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Submitted in partial fulfillment of
the requirements for the degree of

MASTER OF SCIENCE
IN
MANAGEMENT (DATA PROCESSING)

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ABSTRACT

The naval shipyards are in the process of implementing the Bureau of Ships Management Information System for U. S. Naval Shipyards (MIS), which has as its keystone the production planning and control system and as its terminus the cost accounting system. The purpose of the MIS is to improve management techniques in order to reduce cost and meet the challenge of modern technology. A possible extension of the MIS is in the area of material redistribution between shipyards to forestall costly job delays and cancellations. This thesis explores the possibility of establishing a centrally managed redistribution system for material located in naval shipyards employing the techniques of rapid communications and automatic data processing systems. The area of direct material inventory (DMI), which is the most unstructured and uncoordinated, is used to study the possibilities of establishing a feasible integrated naval shipyard material control system to operate in conjunction with the present computerized logistics programs located at the Bureau of Ships.

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CHAPTER I

INTRODUCTION AND THESIS

> When you can measure what you are speaking about and express it in numbers, you know something about it, but when you cannot measure it--when you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind; it may be the beginning of knowledge but you have scarcely, in your thoughts advanced to the stage of science....
>
> Lord Kelvin[1]

In the past decade a host of authors have written about the "sickness" of the shipbuilding industry (commercial and naval) in the United States and have recommended various cures and solutions to the problem. The shipbuilding industry is the epitome of custom and tradition; time and experience, jointly, contributing to the inbreeding of shipbuilding techniques. The response to dynamic and radical technological and managerial change in shipbuilding has been lagging in the United States since 1860. Whereas other industries have developed and met the challenge of new technology and progress and modified their "modus operandi" accordingly, the shipbuilding industry has been entrenched and handicapped by outdated techniques. The following are contributing factors to this "status quo":

1. Complexity of construction
2. Long building period
3. Extensive service time

A ship takes anywhere from one to four years to construct and is kept in service for a normal period of at least twenty years, and

[1] James F. Goodrich, "The Shipyard of the Future," Naval Engineers Journal, (May, 1963), 254.

in some cases as long as thirty years. Periods of war have been feasts in shipyards and immediately upon the cessation of hostilities famine prevails. Evaluating the last 105 years, we have had 17 years of war. Only during the years since the Korean conflict has there been a continued effort to attain constant technological innovation in lieu of being burdened by traditional design and methodology.

Numerous efforts have been made to rejuvenate the shipbuilding industry in both the private and naval sectors of endeavor. These efforts have been successful, but sporadic due to the complexity and magnitude of the problem. Private industry hesitates to invest in major changes, unless it is sure that its primary end, profit, will be achieved. Due to the heavy investment in aged facilities, the high cost of resources (men, material, and overhead), and the problems experienced by the maritime industry in the United States, progress has been slow. Nevertheless the words of James F. Goodrich in his essay "The Shipyard of the Future" are being heeded, to quote:

> Imagination, versatility, and technical competence will be the rudiments of future marine design, building and repair accomplishments. An awesome difficult job must be performed in order to keep the American flag ships at sea and to fulfill the needs of our extremely important military requirements. Somehow in our competitive society, ways are always found to produce what is demanded and, if industry members cannot find a means of providing services to accomplish this task, then imaginative and progressive newcomers, who seem to be ready and willing will find a way.[2]

The newcomers have arrived and are pressing the oldtimers into responsive action. The newcomers are the aircraft companies that have exploited modern scientific management and technological

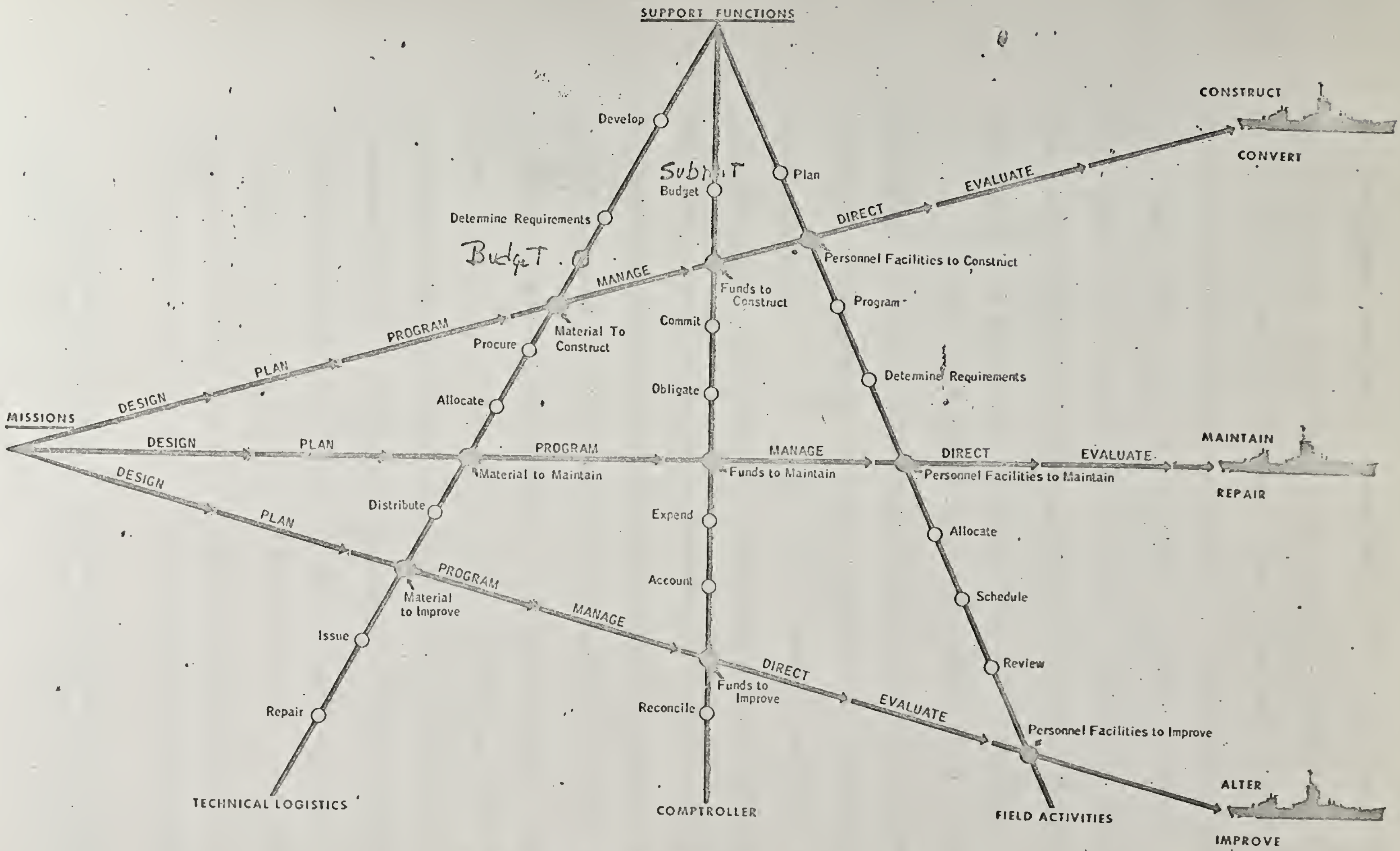
[2]Ibid, 257.

advances to their advantage. Lockheed, Boeing, Aerojet and a host of others have entered the shipbuilding industry and are applying the methods that spelled success in the aircraft industry to shipbuilding. This has caused the traditional shipbuilders to take a closer look at their existing operations and evaluate them in a new light.

The naval industrial shipbuilding complex[3] under the management of the Bureau of Ships (BuShips) has also been affected by the problem of cost. Figure 1 depicts the missions and support functions of the BuShips. Traditionally the naval shipyards are what may be considered the emergency component of the shipbuilding industry, but they are in competition with the private sector. They bid for new construction and conversion work in competition with the private shipyards. Although Congressional action requires the Navy to spend at least 35 percent of the funds made available for ship repair, alterations, and conversions in private shipyards, there is a constant campaign by lobbyists to increase the percentage. This, plus the competition generated by the "program management" and "cost reduction" concepts within the Department of Defense (DOD) have had a stimulating effect on technological and managerial change in naval shipyards.

The post World War II pressures of competition came to bear on the naval shipyards, which had operated mostly as autonomous

[3]At the present time there are ten naval shipyards, namely, Portsmouth, Boston, New York, Philadelphia, Norfolk, Charleston, Long Beach, San Francisco Bay, Puget Sound, and Pearl Harbor. Subsequently, this paper refers to 11 naval shipyards, since San Francisco Bay was created by combining Mare Island and San Francisco Naval Shipyards on 1 June 1965.



BUREAU OF SHIPS MISSIONS AND SUPPORT FUNCTIONS

FIGURE 1

organizations since their inception, even though they were all under the management control of the BuShips. The organizations of all the naval shipyards are basically the same (see Appendix A for a description of a typical shipyard organization and functions); however, some naval shipyards are primarily construction and conversion yards while others are primarily overhaul and repair yards. The advent of the computer provided the impetus for achieving improved management and cost savings in the naval shipyards.[4] Originally the BuShips decided to allow each shipyard to develop its own systems and programs within the limitations of installed equipment. From the initial applications and studies made on different computers by individual shipyards in conjunction with Bureau personnel it was found that a standard automated production planning and control system should be the goal to strive for. The production planning and control system being the means by which the manpower, machines, and material were to be integrated and coordinated to perform the functions in each individual shipyard in an efficient manner. The learning period lasted for approximately ten years, during which time Bureau and shipyard personnel exchanged ideas and gained sufficient experience to commence work on an integrated centrally directed computer system. A study was initiated in 1960 to set a course of action to follow in integrating the management efforts of the 11 shipyards. The result of the study was the "Bureau of Ships Computer Program for Naval Shipyards--Present Status and Planned Actions" dated 1 January

[4]Subsequently, whenever the word shipyard(s) is used, it refers to naval shipyards. Private shipyards will be referred to as such.

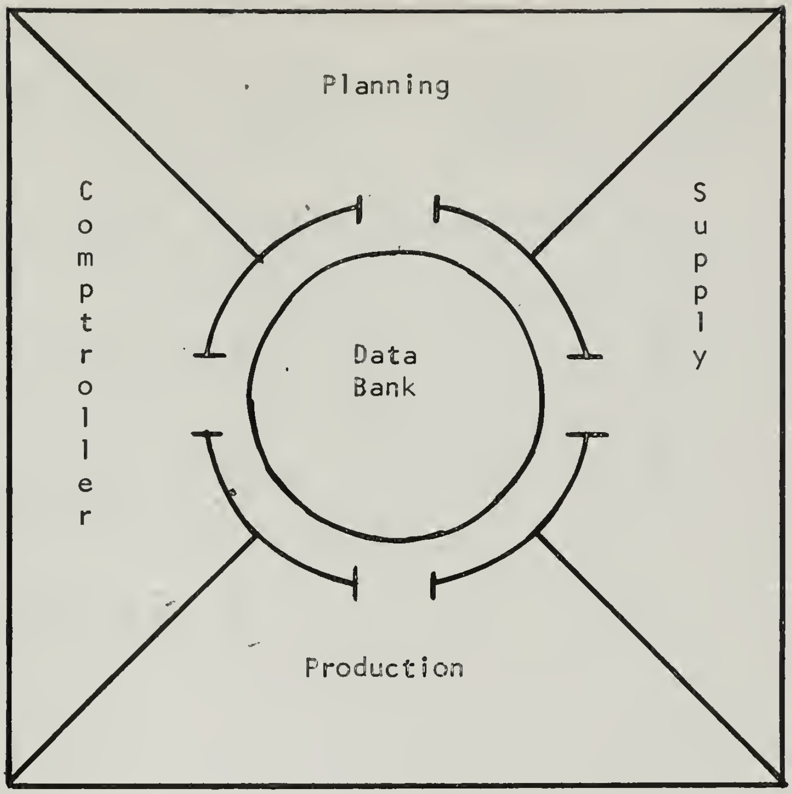
1961. Hence the BuShips Management Information System (MIS) evolved.

The primary objective of the MIS is to develop the production planning and control system as its building block and the cost accounting system as the terminus [55]. Further, to quote from the MIS Manual,

> The system is designed on the principle of providing minimum requirements of management and includes input data, processing logic, and output reports. Emphasis is placed on the integration, consolidation, and multi-use of input and output data.[5]

During the period 1961-1964 the Bureau piloted and tested certain basic phases of the system. In late 1964 and early 1965 incorporation of the system was commenced at the shipyards. At present it is estimated that the MIS, as envisioned today, will be fully implemented in all shipyards by 1967 or 1968. The eventual goal of the MIS is to build a data bank of information at each shipyard which will interlock the efforts of the Planning, Production, Supply, and Comptroller Departments. Figure 2 is a representation of the eventual goal. The efforts of each of these departments is essential to the heartbeat of the MIS.

[5] Bureau of Ships, Navy Department, Management Information System for U. S. Naval Shipyards, Part A. Washington 25, D. C., Bureau of Ships, (1964), I-1.



GOAL--COMMON DATA USAGE

FIGURE 2

THESIS

The purpose of this thesis is to examine the present system of material management in naval shipyards and to project a material management system that will make material available among all shipyards to meet work and delivery schedules. Table I is a synopsis of data gathered to evaluate the effect of the lack of material in shipyards.

The erratic and complicated work patterns in a shipyard make the supply problem different from other industries. The following are specific reasons that make the problem intricate:

RESULTS OF LACK OF MATERIAL IN NAVAL SHIPYARDS

NAVAL SHIPYARD	Portsmouth	Boston	New York	Philadelphia	Norfolk	Charleston	Long Beach	San Francisco	Mare Island	Puget Sound	Pearl Harbor
Number of Jobs Rescheduled* during a Four (4) Week Period Because of Lack of Material	421	Info not available	80	10	73	161	85	49	361	Info not available	500
Waivers Requested Because of Lack of Material During a Year's Period	None	16	5	3	12	7	13	8	11	Info not available	12
Number of Ships that** Missed Departure Date During a Year's Period Due to Lack of Material	Info not available 6,121 jobs	3	2	30-60 key events	None	8	None	None	None	Info not available	2

TABLE I [44]

* Approximately 20-35% jobs scheduled per month

** Approximately 15% missed dates

1. Shipbuilding requirements are generally non-repetitive and highly restricted by the complex nature of the final product.[7]

2. Design and specification information is incomplete or non-available to effect timely procurement.

3. The majority of the equipment installed on active fleet ships is out of production and has been for the past ten to fifteen years or longer. To complicate matters further, plans, specifications, and operating manuals have been lost or are not available to use as procurement references.

4. Emergency requirements and needs generated on the job (open and inspect type) are in many instances difficult if not impossible to satisfy within established procurement times.

5. The nature of the material items makes low cost, short production time on the part of the supplier something less than attractive. It interrupts his planning and production procedures and he cannot always change his schedules to suit the shipbuilder.[8]

6. The decision to procure or produce in-house, where time and cost are of the essence, is a continual matter to be contended with.

7. The dependence on the planning and production departments for specifications, interpretation, progressing, expediting, and inspection in effecting a procurement.

8. Assurance that material procured meets quality and reliability specifications.

[7] D. M. Kaetzel, LCDR, USCG, "A System of Management Control Applied to Shipbuilding," Naval Engineers Journal, (May, 1963), 282.

[8] Ibid.

The above lead to the conclusion that there is a need for a system which can make use of all the material sources available. In addition, the system must provide firm, accurate, and timely material information and a measure of control over material status.

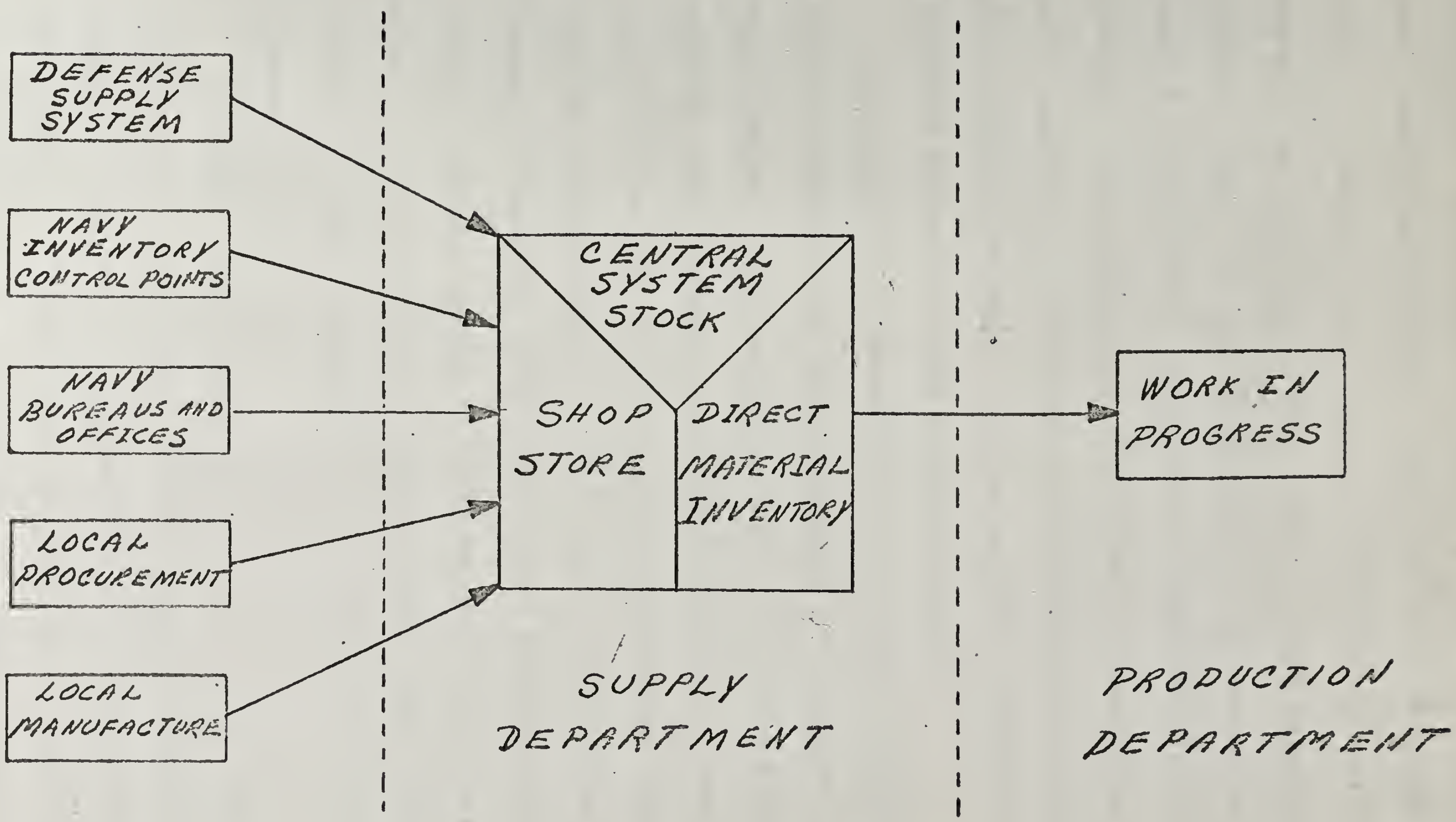
Material for use in shipyards is procured and/or requisitioned from the following sources:

1. Defense Supply System
2. Navy Inventory Control Points
3. Navy Bureaus and Offices
4. Local Procurement
5. In-house Manufacture

Upon receipt of the material in the shipyard, it falls into four categories:

1. System Stock in Central Storerooms
2. Shop Store Stock
3. Direct Material Inventory
4. Work in Progress

The material in the preceding first three categories is under the control and custody of the Supply Department, while work in progress is under the control and custody of the Production Department. Figure 3 is a representation of the flow of material from the initial sources to work in progress (ultimate use). The system stock in the central storeroom is held in either a revolving stock fund or appropriation fund account. The shop store and direct material inventory stock are in the Navy Industrial Fund, which is managed by each shipyard. The work in progress is expended to the ship or project being worked on.



MATERIAL FLOW IN NAVAL SHIPYARDS

FIGURE 3

There is no standard method for processing material to work in progress. It may come from any or all three of the holding areas, namely, central stock, shop store, or direct material inventory. Some shipyards process all material into central stock before it is transferred to shop store or direct material inventory. Others only send system material to central stock, common low cost everyday usage items to shop store, and material inventory. Shop stores vary in size and in numbers at all shipyards, depending on the mission and the need of the shipyard. Direct material inventory is either centrally located or spread throughout the various shops using the material.

In evaluating and developing the integrated naval shipyard control system the three major categories of releasable material, namely, central stock, shop store material and direct material inventory were considered. Upon investigation the authors concluded that the most unstructured and uncoordinated segment from which the greatest benefit could be reaped was the direct material inventory. Therefore, a detailed analysis based on the direct material inventory records of two shipyards, Mare Island, which is primarily a new construction yard, and Pearl Harbor, which is primarily a repair yard was made. The results of the analysis are presented in Chapter III.

The major factors affecting a decision whether material is available to be transferred from one shipyard to another are evaluated in Chapter II. The decision rule is also considered in this chapter. As will be seen, the decision to move material from one shipyard to another is primarily dependent on the imminent use by the Production Department, the time required to procure the

material, and the type job the material is to be used on.

Chapter IV develops the Automatic Data Processing System (ADPS) using a central data bank established at the BuShips Headquarters for determining whether material should be moved from one shipyard to another to prevent work stoppages and delays. It is based on present ADPS facilities at the BuShips with proposed modifications to insure timely processing.

Conclusions and recommendations resulting from the thesis are presented in Chapter V.

SUMMARY

The naval shipyards are in the process of implementing the MIS, which has as its base the production planning and control system and as its terminus the cost accounting system. The purpose of the MIS is to improve management techniques in order to reduce cost and meet the challenge of modern technology. A possible extension of the MIS is in the area of material redistribution between shipyards to forestall costly job delays and cancellations. This thesis explores the possibility of setting up a centrally managed redistribution system employing the techniques of rapid communications and automatic data processing systems. The area of direct material inventory, which is the most unstructured and uncoordinated, is used to study the possibilities of establishing a feasible integrated naval shipyard material control system.

CHAPTER II

DEVELOPMENT OF THE DECISION RULE TO PROVIDE MATERIAL

Webster's New World Dictionary defines "decision" as "the act of deciding or settling a dispute or question by giving a judgement." Before an action can be taken to move material from one shipyard to another a well founded decision must be made to determine whether the move is justified. At present there is a standard Department of Defense (DOD) priority system, Uniform Material Issue Priority System (UMIPS), which assigns priorities based on mission category of the unit requesting material and criticality of the material to the performance of the mission. This priority system, as others before it, becomes contaminated from time to time due to the fact that the priorities are raised arbitrarily in order to expedite material when it is not received on time. The aviation, FBM, and other specialized segments of the Navy have resorted to qualifying their priorities, for example, the aviation segment uses codes for AOCP (Aircraft Out of Commission), ANFE (Aircraft Not Fully Equipped), etc. The ingredients that go into the determination of a priority for material are a mixture of substantiated fact and subjective judgement. The fact is indisputable; however, the judgement can be questioned more often than not.

Analysis of the various approaches in the development of a decision rule for moving material from one shipyard to another established that the present DOD priority system would not be satisfactory in itself, and that an unbiased method to be applied to a series of related factors at the headquarters level was necessary. Immediately the problem of quantification arose.

Tangible and intangible aspects presented themselves and had to be weighted in their proper perspective. The tangible aspects, such as cost of a job, project, or overhaul may be quantified; the intangible, such as readiness and military worth are difficult if not impossible to quantify.

In order to provide a basis for a meaningful decision rule, regarding material requirement availability in shipyards, the following areas must be considered and evaluated:

1. Work Scheduling and Forecasting
2. Quality Control Standards
3. Transportation Effectiveness
4. Material Essentiality
5. Non-Standard Material Identification

The above five areas have been controversial in material and production planning and control decisions for time immemorial. Therefore, before attempting to devise a decision rule to apply to DMI transfers between shipyards the authors will make the following assumptions and subsequently, briefly, discuss each area mentioned above.

Assumptions

1. A totally feasible automatic data processed work forecasting and scheduling system, including PERT and PERT/COST capability, will be available at all naval shipyards. (This is not provided for in the present MIS; however, it is mentioned as a partial extension of the MIS.)

2. Quality control techniques and practices that have been standardized and proven feasible will be in use.

3. A common non-standard material identification system will

be developed and available for use among shipyards.

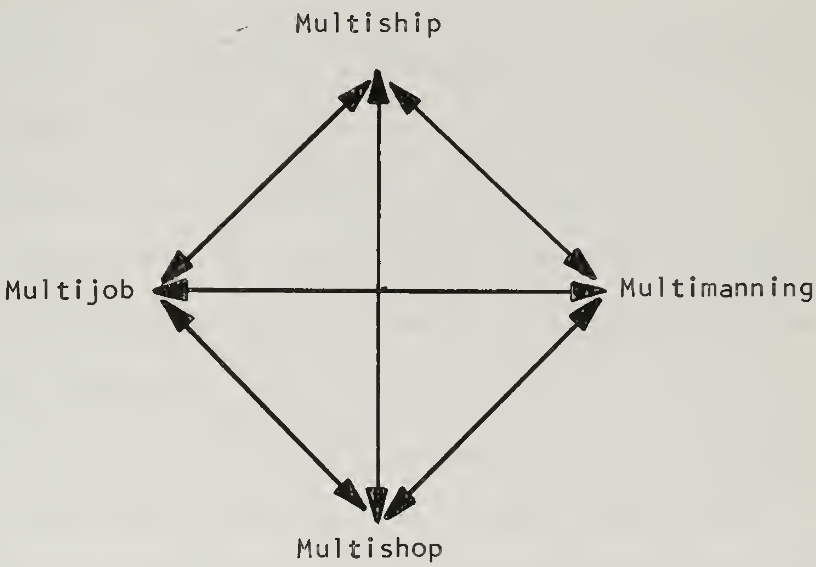
WORKLOAD FORECASTING AND SCHEDULING

Workload forecasting and scheduling is an intricate problem in any industry; however, it is more involved by the erratic and complicated work patterns in shipyards. The continual changes in new construction, conversion, and repair programs as a result of the changing state of the art and dynamic technological advances is further affected by the unscheduled call for emergency repairs to active fleet ships. The introduction of the idea of the production planning and control system in 1952 attempted to deal with the problem; however, only minor advances were made. The only automated data processing equipment available at that time was card punch equipment. It was not until the advent of the computer in 1957 and its application to forecasting and scheduling that the true potential of accurate forecasting and scheduling was realized. Studies of the problem by individuals, also contributed greatly to expanding the advantages of ADPS in this area. Two studies in particular, one by Joseph F. A. Ormsby [22] and the other by F. K. Levy, G. L. Thompson and J. D. West [19] have provided a number of basic insights into the problem.

The workload forecasting and scheduling system in shipyards is an interrelationship of the following four multifarious factors:

1. Multiship
2. Multijob
3. Multishop
4. Multimanning (work force)

Interdependence of the four factors is illustrated in Figure 4 below. Manipulation of the data generated by the factors, to provide timely and useful management information, is nearly impossible except by an integrated automatic data processing system. The shipyard departments primarily involved in coordinating the data for the above factors are Planning, Production, and Supply. Here again the production planning control and material systems form the backbone of the industrial effort. Only through constant attention and revision can economy of resources (personnel, machinery, and material) be achieved in completing shipyard work on schedule.



WORKLOAD FORECASTING AND SCHEDULING

FIGURE 4

The following automatic data processing workload forecasting and scheduling system is proposed by the authors. It assumes that incorporation of the MIS has been completed and the availability of, at least, a computer having the characteristics of the UNIVAC III in all shipyards. (See Figure 5)

1. Upon receiving information that a ship is to be constructed, converted, or repaired (overhaul, emergency, or restricted availability) the shipyard involved will establish milestones for the completion of key events.

2. The various jobs to be performed are determined and classified as controlling or non-controlling.

3. The jobs are assigned to the shops concerned.

4. Manning levels are assigned to the jobs by the individual shops concerned.

5. PERT/COST networks are developed for controlling jobs. (See Figure 6)

6. A master work schedule is established for performing work on the particular ship.

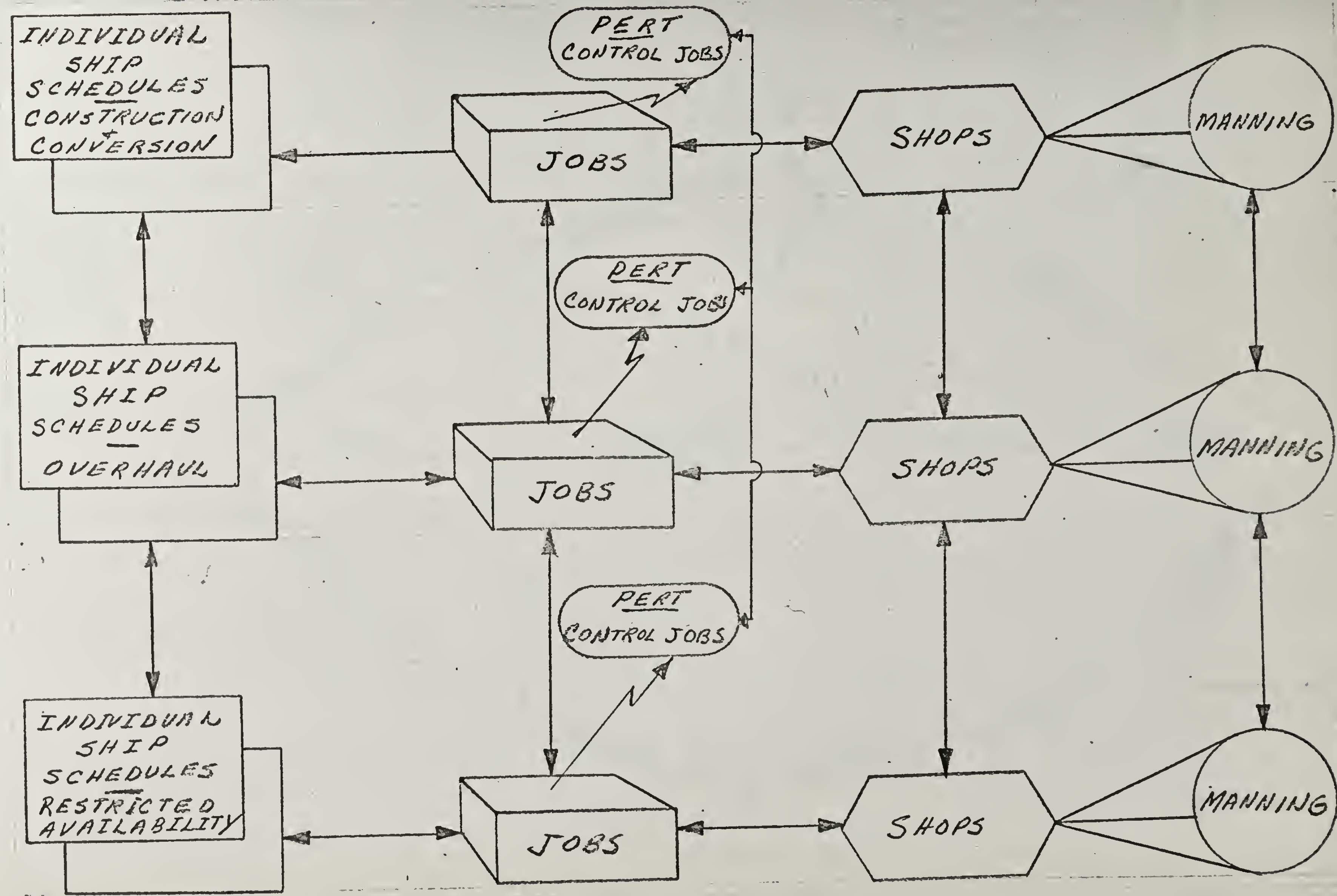
7. The master work schedule for the ship is integrated with all other shipyard work into the shipyard master work schedule.

8. The PERT/COST controlling jobs are integrated into the shipyard master PERT/COST schedule.

9. The master work schedule is processed and reviewed biweekly, and regular and exception reports are printed out.

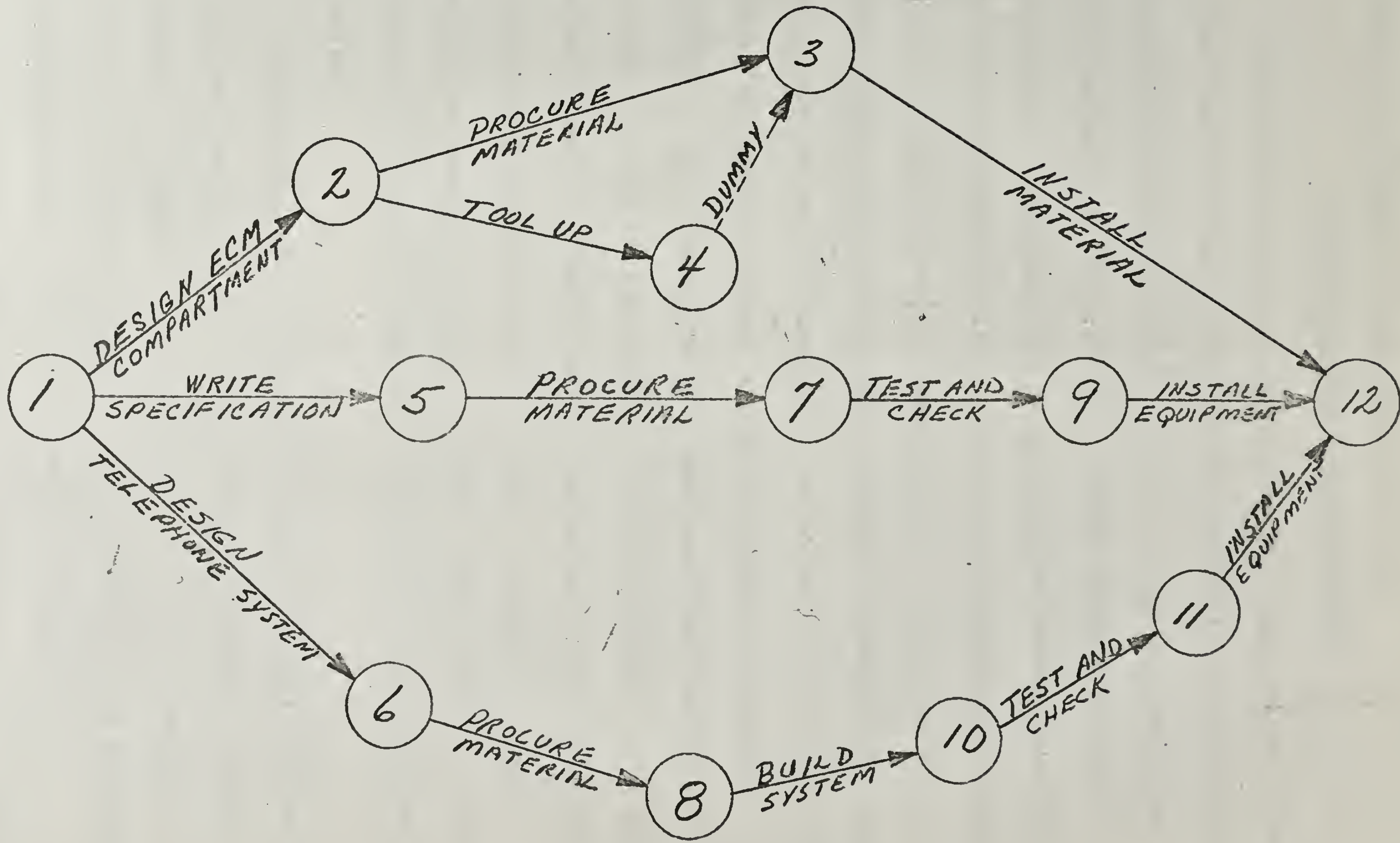
10. The master PERT/COST schedule is processed biweekly, and regular and exception reports are printed out.

Exception data from the reports developed above is processed by the Planning, Production, and Supply Departments. In the case of material, local action is taken to locate and expedite delinquent material. However, if local action is unsuccessful, a requisition is forwarded to the direct material data bank at the BuShips to interrogate the bank as described in Chapter IV. If the material is available in the system for redistribution the work schedule is



SHIP-JOB-SHOP INTERRELATIONSHIP

FIGURE 5



SAMPLE PERT NETWORK

FIGURE 6

not changed; however, in the event material is not available the schedule is changed and adjusted accordingly.

QUALITY CONTROL STANDARDIZATION

The growing need for an effective and standardized quality control program is emphasized by the utilization of more unusual materials and methods to meet the ever increasing demands of ships' performance requirements. Quality control actions originate in the preparation of the specifications, drawings, and purchase orders for material. The various Department of Defense and Naval Bureaus, Offices, and Agencies, private industry, and professional societies have been constantly searching to develop strict quality control standards. In spite of this concentrated effort, differences between the quality control procedures employed at naval shipyards have been continually evidenced. As has been the authors experience, it is not uncommon for a shipyard urgently needing material, which has had local shipyard quality control restraints put on it, to locate identical or similar material at another shipyard; however, being unable to use this material due to the difference in standards at the shipyard in question.

As mentioned above, the quality control effort must start with the inception of the idea that material meeting certain standards is needed. O. R. Goode and J. F. Dallinger [13], in their paper, "Quality Control in Shipbuilding," have recommended the following steps to insure maximum effectiveness.

1. Purchase orders should be reviewed by quality control orientated personnel.

2. The potential vendor should be evaluated for quality

control practices.

3. The vendor's plant should be subjected to a quality control inspection by the DOD Inspection Service.

4. The shipyard receiving division should have a quality control inspection branch.

Upon inspection the material should be marked that it meets a certain quality control level. Only specified markings should be used that were obtained from standards developed for all shipyards. BuShips is presently in the process of developing standard inspection and marking procedures, and also pursuing a program to insure conformance to specified standards. However, it is a long and tedious procedure that will take years to implement. Only through the continued review and attempt for excellence on the part of individual shipyards and through central guidance from the BuShips will the information be current and usable in the long run.

TRANSPORTATION EFFECTIVENESS

The effects of transportation on the decision rule to move material from one shipyard to another were considered to be a major factor. Upon investigation of the subject, it was found that the DOD transportation system, Military Standard Movement Procedure (MILSTAMP), was completely satisfactory from the technical viewpoint of making the decision as to what mode of transport to use. It would depend on the priority assigned to the requisition and the date material was required by the using activity. The only decision that would have to be made at the headquarters level is in the case where the same material was

available from two sources. Here the closest source would prevail, all other things being equal. If all other things were not equal, the material designated for the latest use would be shipped, irrespective of distance.

ESSENTIALITY

The essentiality of the various components of a ship to its mission capability has been a subject that has been studied and evaluated continuously during the last decade. It has been approached from two directions, namely, the subjective method of "experience" and the scientific method of probability and reliability. In both methods the governing factors that precluded widespread application of the systems devised were the prohibitive costs of installation and the changing state of the art of technology. Hence, the material needs of shipyards are best expressed by their categorization of jobs applicable to a ship as controlling or noncontrolling. As implied by the words, a "controlling job" is one that will affect timely completion of a job before the ship puts out to sea. The breakdown can be further refined by identifying the system to which the job applies, namely, main, auxiliary, or collateral.

IDENTIFICATION OF NON-STANDARD STOCK MATERIAL

The inventories of naval shipyards consist of both standard and non-standard stock material. Standard stock material has a federal stock number (FSN) assigned and non-standard stock has not. MIS procedures call for the assignment of a locally assigned number to identify material that does not have an FSN assigned to it. Upon review, some shipyards were assigning local numbers and

others were not; however, in the case where two shipyards were assigning local numbers they were different even in the case of the same material.

In order to operate a centralized data bank for screening material requirements, the standard material identified with an FSN will present no problems. However, a standard method must be developed for identifying non-standard material that does not warrant FSN assignment. Upon researching the field, the authors found that there were a number of standard practices both in the DOD and in private industry that could be combined to give a standard identification of non-standard material between shipyards. An identification number could be constructed by combining the following elements:

1. Federal Supply Classification as listed in the Cataloging Handbook, H2-1 [38]
2. Manufacturer's Federal Identification Number--5 digit code
3. Manufacturer's Part Number
4. Quality Control Code

In the event that the manufacturer does not have an identification number one could be obtained from BuShips, where a supplementary list of manufacturers' identification numbers would be centrally controlled. A standard requirement could be placed on all manufacturers to assign a part number to all materials.

Using the above format it is estimated that at least 25 digits would be required for a locally assigned standard number.

Nomenclature	Digits
1. Federal Stock Class (FSC)	4
2. Manufacturer's Identification	5

Nomenclature	Digits
3. Date Material Required	15
4. Scheduled Date of Departure	1

DECISION RULE

The primary consideration in developing an integrated naval shipyard material control system is that all material in the system is positively identified, whether it be standard or non-standard stock. Therefore, before proceeding with the development of the decision rule it must be assumed that a satisfactory and compatible system has been incorporated for identifying non-standard material locally at each shipyard.

In developing a decision rule for the transfer of material from one shipyard to another, four primary factors must be considered and weighted, namely:

1. Military Worth and Readiness
2. Type of Job
3. Date Material Required
4. Scheduled Date of Departure

Under present operating conditions a ship that enters a shipyard is downgraded in mission category as defined in the UMIPS, which is its only official indication of military worth and readiness. While it is in the shipyard it takes on the mission category of the shipyard and the relative importance given to its eventual mission is a matter of how much official or unofficial pressure the Chief of Naval Operations (CNO), the type commander, or the ship's commanding officer exerts. This situation may be corrected by assigning a military worth and readiness

precedence to ships entering shipyards, either individually or by class. Table II is a proposed index system by class. The system could be administered by the BuShips in conjunction with the CNO, who has the ultimate control and responsibility for the ships.

The type of job may be broken down into the following order of priority:

1. Emergency Repair
2. Restricted Availability
3. Overhaul
4. Conversion
5. Construction

The first two categories above, inherently, identify the urgency of the requirement; however, additional factors must be applied for the last three categories. The effect of not having the material on the continuation of the program, i.e., overhaul, conversion, or construction, must be evaluated. If the material needed must be installed before further work can progress or if it is needed to button up a compartment, it has precedence over work that can be by-passed in the stage that it is in and completed later. Therefore, the two additional factors must be incorporated, namely:

1. Work Stoppage
2. Non-Work Stoppage

See Table III for all possible index values.

The date material is required (DMR) and the date of scheduled departure (DSD) may be obtained from an up-to-date workload forecasting and scheduling procedure. It is important that these dates

SAMPLE MILITARY WORTH AND READINESS BY SHIP CLASS	
CLASS	INDEX
FBM Submarine	1
Nuclear Submarine	2
Aircraft Carriers	3
Submarines	4
DLG's	5
DDG's	6
.	.
.	.
.	.
Etc.	Etc.

TABLE II

SAMPLE TYPE JOB	
JOB	INDEX
Emergency Repair	1
Restricted Availability	2
Overhaul-Work Stoppage	3
Conversion-Work Stoppage	4
Construction-Work Stoppage	5
Overhaul-Non-Work Stoppage	6
Conversion-Non-Work Stoppage	7
Construction-Non-Work Stoppage	8

TABLE III

be exact dates, for the integrity of the system will be dependent upon them. The dates will be submitted to the central data bank as Julian dates for ease of computation.

In analyzing the above data and evaluating various possible decision rules it was decided that the following would be most satisfactory and representative of the urgency. Represented mathematically it is:

$$\text{Decision Rule} = f_{DEC} = \frac{1}{\text{Military Worth and Readiness}} \times \frac{1}{\text{Type Job}} \times \frac{1}{(\text{DSD-DMR})} \times 100$$

In this way a high value will have the higher priority, for example a FBM submarine under emergency repair with a DSD of 5100 and a DMR of 5090 would have a f_{DEC} of $f_{DEC} = \frac{1}{1} \times \frac{1}{1} \times \frac{1}{(5100-5090)} \times 100 = 10$

while an aircraft carrier in restricted availability with a DSD of 5100 and DMR of 5080 would have a f_{DEC} of

$$f_{DEC} = \frac{1}{3} \times \frac{1}{2} \times \frac{1}{(5100-5080)} = \frac{5}{6} = 0.83$$

The above decision rule is one that could be easily calculated by a computer and would allow for automatic decision making rules to move material from one naval shipyard to another. It, however, is not an end in itself, if justified a material coordinator or program coordinator at a type desk in BuShips or CNO could make the final decision whether to move material or not.

SUMMARY

In the development of any integrated material management system, two suppositions are necessary, (1) an adequate standard identification system and (2) and impartial priority system. The material in naval shipyards falls into two categories: standard,

identified by a Federal Stock Number (FSN), and non-standard, identified locally at each activity. Material identified by a FSN poses no problem, however, a standard identification system for non-standard material, based on the federal supply classification system, must be devised for use among shipyards. In the UMIPS, priorities are assigned by mission and criticality. However, the relative importance of ships undergoing construction, conversion, and overhaul at shipyards is not incorporated in UMIPS. Therefore, after consideration of a number of critical factors, such as, workload, essentiality, etc., it was decided that the following decision rule would adequately classify material requirements for ships in shipyards:

$$\text{Decision Rule} = f_{DEC} = \frac{1}{\text{Military Worth and Readiness}} \times \frac{1}{\text{Type Job}} \times \frac{1}{(\text{DSD-DMR})} \times 100.$$

CHAPTER III

DATA GATHERING AND DIRECT MATERIAL INVENTORY (DMI) PROJECTION

The question regarding the feasibility of one shipyard using another shipyard's DMI on a programmed basis to fulfill emergency requirements appears as if it could be answered with a simple intuitive "yes" or "no." In fact, this is an alternative to the shipyards now, however, on an informal random basis. To what extent this alternative is pursued is directly related to the urgency of the situation, and amount of frustration the requiring shipyard experiences in fulfilling material needs through normal channels. Initially the authors thought that the problem of utilization of DMI could be answered through historical records or interviews. Specific areas of concern were the categories of materials likely to be of a problem nature and thereby be of value in monitoring; the range and depth of this problem category material in each shipyard's DMI; and the average age of material in each shipyard's DMI. It is obvious that these areas are intimately related to the feasibility of a formal integrated screening and utilization system. As will be seen in subsequent discussion, this information was not readily available as originally thought.

Initial results from interviews with various shipyard personnel regarding the subject of past or present utilization of other shipyard's DMI as an alternate means of supply gave an early indication of the difficulties the authors would have in quantifying needed data. In fact, in this particular area, the authors came to the embarrassing conclusion that a meaningful figure could not be obtained.

Efforts to obtain specific judgements as to material susceptible to creating procurement problems received minimal response from interviews. In general, there was agreement to the fact that such materials as pipe, tubing, fittings, and valves were good candidates to be classified as critical due to stringent quality control requirements placed on these materials for use on submarines[1] and the difficulty in obtaining them from the supply system or through local procurement. Data relative to the total number of problem items, the range of items held in DMI, or even the average age of material was not explicitly available, nor were personnel interviewed able or willing to venture a guess as to what these figures might be. There was some agreement that 5% of DMI ordered would be eventually returned unused. The authors feel this figure low and that it probably ranges as high as 20%. No documentation, however, is available to substantiate the feelings of the authors.

At this point, it became apparent that certain information required for this study would not be available historically and it was further recognized by the authors that the answers to other questions asked, such as, the cost of not having material available when required, the cost of a ship missing a completion date, and the identification of a nonstandard item in some conventional way would be equally as nebulous.

As a result of non-existent historical data, the authors

[1]As a result of the "Thresher" incident, high quality control measures were instituted on material used in submarines, i.e., fittings, valves, etc. These measures were effected through what is called the "Subsafe" Program.

found it necessary to take a more hypothetical and basic approach to answering the queries posed above. This required reconstructing the item make up of a shipyard DMI based on manual sampling or other means. In this regard Pearl Harbor and Mare Island agreed to writing their DMI files[2] on magnetic tape provided by the authors. With the raw data available on tape, it was then possible to obtain a major sampling of both a repair and construction shipyard's DMI.

Although not without problems, it was decided to attempt to analyze material shown on these DMI runs, and from this data generalize distributions to all yards. To do this, it was necessary to rely quite heavily on direct ratios between investment and average money value per line item as generated from Pearl Harbor and Mare Island tapes. Specific information which will be projected on the basis of data obtained from these tapes is as follows:

1. Range of line items for all shipyards.
2. Average unit price and money value per line item on hand.
3. Average time a requisition is outstanding.
4. Average age of material in DMI.
5. An upper bound for line items of material susceptible for screening and review under the system proposed by this paper.

The average projections, as a result of the scarcity of information available regarding these areas, must be made on the basis of some rather general assumptions and in some cases arbitrary

[2]Pearl Harbor DMI run (001 matl M-1) and Mare Island DMI run (DMI011 MASTRYMODARL)

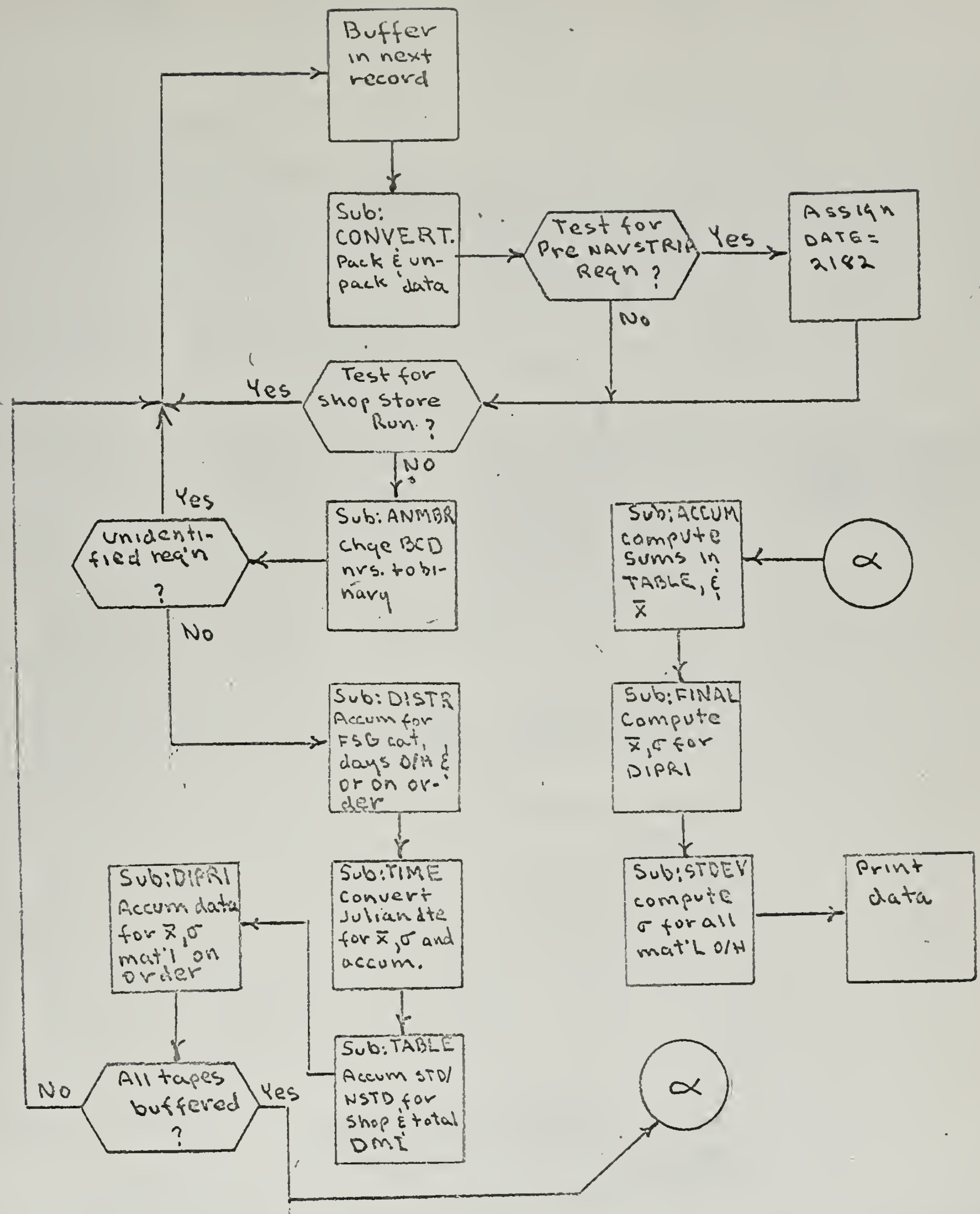
decisions on the part of the authors. These matters will be discussed more fully in subsequent paragraphs.

Since these DMI tapes were maintained on computers other than the CDC 1604 (U. S. Naval Postgraduate School computer), and tape formats differed, considerable programming effort was required to extract data pertinent to this paper. In spite of inconsistencies found between both shipyards in data maintained and coding, tape errors, the inclusion of an extraneous run in the Pearl Harbor tape, the results of the runs proved reasonably consistent. These particular problems and others which will be discussed were not fully appreciated by the authors at the outset of this study and may partially explain why this aspect of shipyard activity has not been previously investigated.

An initial problem faced by the authors was that the record lengths on the DMI tapes were variable and not compatible to the CDC 1604. This required the use of the U. S. Naval Postgraduate School program A5CPY03 to copy and expand BCD data contained on the tapes to record lengths compatible to the CDC 1604. Probably the most difficult initial problem faced was that of determining what information was available and how to extract it. As a result of the differences between coding and format at the individual activities, identical categories of information were not, in all cases, available from both tapes. For instance, Pearl Harbor's tape identified material on order and on hand, whereas Mare Island's tape only showed material on hand. In the area of standard and nonstandard material, Mare Island identified its non-standard material with a Federal Supply Class (FSC) and a locally assigned number whereas Pearl Harbor did not. Due to these report

inconsistencies it will be necessary to generalize deficiencies of one report from information contained in the other. This is not felt unreasonable in light of the results of our analysis which points to a basic similarity between material used in shipyards.

The basic flow diagrams for programs used to extract data from the DMI tapes are shown on the following pages.

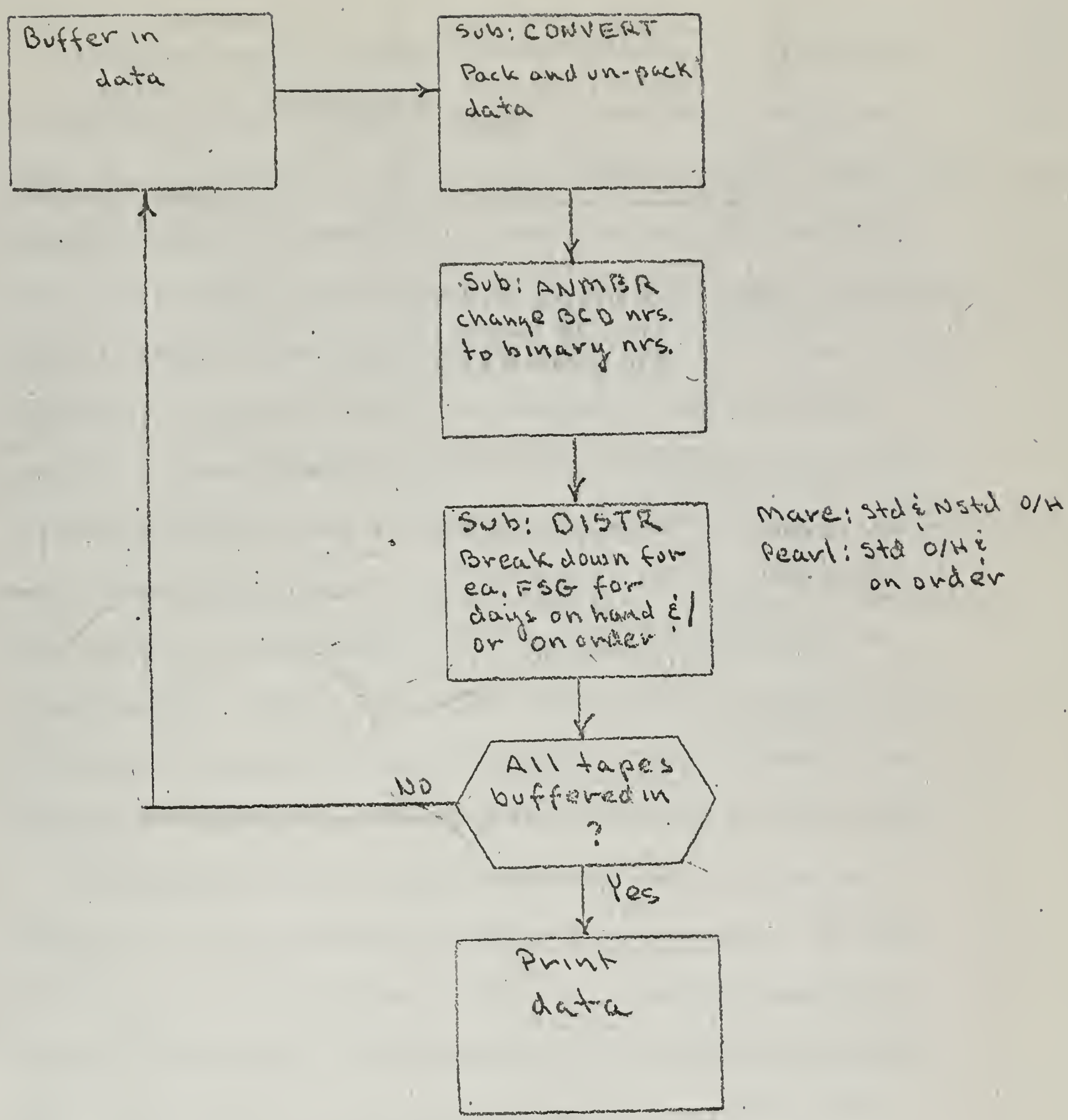


PEARL HARBOR[3]/MARE ISLAND[4] GENERAL MATERIAL

FIGURE 7

[3]See Appendix B for program and output.

[4]Program flow is similar to Pearl's. Major coding differences occur in the subroutines. Also, subroutines DIPRI and FINAL are not used in Mare Island's program. See Appendix E for program and output.



PEARL HARBOR AND MARE ISLAND
FINE MATERIAL BREAKDOWN PROGRAMS[5]

FIGURE 8

[5]Same executive program and tests as flow charts shown in figure 7 with the exception that only the DISTR sub routine is used. DISTR has been changed to obtain breakdown by specific FSG and to show also material on hand or on order in 30 day increments for the period 60 to 179 days. See Appendices C and D for Pearl Harbor and Appendix E for Mare Island programs and out puts.

Although a data breakdown by shop of material on hand and in the case of Pearl Harbor material on hand and on order was made, its significance is only to show that the type of work each shipyard does may be reflected in the distribution of material used by its shops. Pearl Harbor primarily does repair work (RO's) which in recent years has tended to submarine rather than surface ship work. This can possibly be inferred by looking at the quantity of material used by shop 56.[6] This would also explain the more relatively even distribution of material shown on hand or on order for the major shipyard shops. On the other hand, Mare Island is a construction yard specializing primarily in submarine work. Again, this could be inferred by looking at the shop general material breakdown[7] because of the extremely heavy quantity of material used by shop 56 in relation to other shops.

For purposes of this paper, the decision as to whether a shipyard is a construction/conversion yard or not will be made on the basis of information contained in a BuShips memorandum showing "Fiscal Year 1964 Management Data for Naval Shipyards" [54]. The criteria for making this decision was that a shipyard receiving decidedly more income from construction and conversion than other type of work would be judged to be a construction yard. Borderline cases such as Boston and San Francisco were designated construction and repair yards respectively assuming that annual fluctuation of work could put them in one category or

[6]See Appendix B. Shop 56 uses pipe, fittings, and valves, etc., which are major commodities in submarine work.

[7]See Appendix E.

another. The remaining shipyards were identified as repair yards. It is recognized that this method may be somewhat arbitrary, but is not entirely unfounded. Presented below are income figures for DMI and Shop Store investment during fiscal year 1964 [54].

SHIPYARD DMI/SHOP STORE INVESTMENT
(Thousands $)
CONSTRUCTION/CONVERSION YARDS
30 June 1964

	PTSMH	BSN	NY	PHILA	BREM	MARE
Direct Material	9,115	2,760	4,795	2,984	4,877	8,224
Shop Stores	2,196	1,872	1,438	2,575	2,480	3,115

REPAIR - ALTERATION - MODIFICATION YARDS

	LBEACH	SFRAN	NORVA	CHASN	PEARL
Direct Material	61	3,647	941	1,015	1,086
Shop Stores	1,315	2,050	3,206	2,390	1,526

TOTAL YARDS

Direct Material	39,505
Shop Stores	24,163

TABLE IV

The reason for making the distinction between repair and construction shipyards is necessitated by the significant difference found[8] in the relative use of standard and nonstandard material and certain Federal Supply Groups (FSG),[9] i.e., 47 and 95 by each type of shipyard and the fact that a means was needed to project a hypothetical figure for DMI on hand and on order for

[8]See Appendices B and E and Table VII

[9]The first two digits of a stock number, FSG, identifies a particular commodity grouping. This group is part of the FSC which further identifies a relatively homogeneous area of commodities.

all shipyards. In order to facilitate presentation, the authors have grouped the FSG's arbitrarily into nine general material categories, numbered one through nine. A summary showing some of the more pertinent results of the general material breakdown runs for Pearl Harbor and Mare Island is shown in Tables V and VI.

PEARL HARBOR STANDARD/NONSTANDARD
GROSS COLLECTIVE DMI DATA

Type of Material	Line Items On Hand	Average Unit Price	Sum Money Value	Average Money Value Per Line Item	Line Items On Order
Standard Stock	12,282	$27.69	$923,069.	$75.16	3,995
Non-Standard Stock	2,196	$277.87	$1,207,911.	$550.05	4,004
Total DMI Screened	14,478	$65.63	$2,130,980.	$147.19	7,999

TABLE V

The sum of total money value generated from the Pearl Harbor DMI tape overstates total DMI investment as reported at the end of March 1965 [51] by approximately $500,000. Possible reasons for this difference are as follows:

1. A portion of the inventory may have been written twice on the tape by Pearl Harbor since an indication was made by Pearl Harbor that this could have occurred. It was found that a portion of the Shop Store inventory had been written on this tape and the authors were eventually able to screen these items out. Use of a Postgraduate School dump routine[10] failed to reveal any duplication

[10] A7 T DUMP01 routine prints BCD data from tape to print on the IBM 1403 printer.

in the areas tested.

2. Some materials may be held in DMI, but are not reported. One of the authors recalls where "F" and "S"[11] cognizance material, for instance, which is not chargeable had been issued to DMI on a paper transaction basis to locate material for call out by the shop.

3. The authors may have misinterpreted some of the key screening codes when developing the program to analyze this tape. However, review of the programs does not reveal any basic logic faults.

4. Normal job closure, material excessing, or material issue could account for part of this difference. However, it is felt that at a repair yard it would not occur to such an extent in a period of a several weeks which is the time difference between the run results and report spoken of.

MARE ISLAND STANDARD/NONSTANDARD
GROSS COLLECTIVE DMI DATA

Type of Material	Line Items On Hand	Average Unit Price	Sum of Money Value	Average Money Value Per Line Item
Standard STOCIC	1,994	$24.19	$476,550.	$238.99
Non-Standard STOCIC	16,179	$57.07	$5,432,386.	$335.77
Total	18,173	$53.46	$5,908,936.	$325.15

TABLE VI

The sum of total money value generated from the Mare Island DMI tape understates the value of DMI inventory reported in March

[11]Major BuShips equipment which Pearl Harbor is a primary stock point for.

1965 [50]. Possible reasons for this difference are as follows:

1. In order not to duplicate data it was necessary to key on Mare Island's overflow Master Indicator. Although several tape dumps[12] were made, no indication was found that pertinent data had been overlooked.

2. The method by which Mare Island accomplished adjustments was rather complicated and made it difficult to tell whether keying on all financial parts of the basic record and associated detail records would prove worthwhile. Consequently, due to lack of time, only the unit price and current value of the item shown in the basic record were keyed upon. The consequence of this, if any, would be to reduce the average money value per line item. Were this the case, it would be more preferable than to overstate the average money value per line item for purposes of this paper.

3. There is also the possibility that the figure obtained from the Mare Island tapes was correct and the increase could have resulted from large quantities of material received or turned in, which is not inconceivable.

As mentioned earlier, to facilitate presentation and study of the distribution of types of material which make up the DMI inventory, it was decided to segment material into nine categories. Each category, except category one, which hypothetically is made up of FSG's zero through nineteen, consists of ten FSG's. This measure also bridges the problem of compensating for discontinuity created by non-existent FSG's, i.e., '33', 50, 57, to mention a

[12] Postgraduate School routine A7 TDUMP01 was used which writes BCD data from tape on 1403 printer.

few [38].

Although not specifically intended, the distributions of material categories for both Pearl Harbor and Mare Island almost have the resemblance of the familiar normal curve. However, such is not the case, particularly in the case of Mare Island. Due to the difference in content of the tapes, as previously discussed, data pertaining to material on order at Mare Island was not available nor was there a means for categorizing Pearl Harbor's non-standard material. Nevertheless, there is a similar trend between the types of standard stock materials used and, because of this reason it will be used extensively in making total shipyard projections. Presented on the following pages are the more pertinent distributions constructed from raw data obtained from programs analyzing Pearl Harbor and Mare Island DMI tapes.[13]

[13]See Appendices B through E for further detail.

MARE ISLAND/PEARL HARBOR FSG-CATEGORY DISTRIBUTIONS

DMI PEARL HARBOR STD STK						DMI MARE ISLAND ON HAND			
				TOTAL A					
		On Order		On Hand		STD STK		Non STD	
CAT.	FSG	Freq	Rel. Freq	Freq	Rel. Freq	Rel. Freq	Freq	Rel. Freq	Freq
1	-19	202	.051	739	.061	.00	0	.00	3
2	20-29	182	.046	721	.059	.001	2	.001	18
3	30-39	196	.049	782	.063	.019	39	.022	355
4	40-49	790	.198	3337	.272	.339	672	.618	9969
5	50-59	1737	.434	4348	.435	.385	764	.189	3054
6	60-69	576	.144	724	.059	.04	80	.048	774
7	70-79	42	.011	112	.009	.001	2	.003	42
8	80-89	49	.012	59	.005	.003	6	.002	32
9	90-99	221	.055	460	.037	.212	417	.117	1890
Total		3995		12282			1982		16137

THIRTY OR MORE DAYS
(AGED)
B

1	-19	170	.072	524	.047	.00	0	insig.	3
2	20-29	119	.051	689	.062	.001	2	.001	12
3	30-39	139	.059	718	.064	.020	35	.022	340
4	40-49	526	.224	3098	.278	.349	627	.62	9109
5	50-59	861	.368	4889	.439	.383	688	.187	2869
6	60-69	378	.162	680	.061	.032	58	.048	749
7	70-79	28	.012	108	.010	.001	2	.003	42
8	80-89	38	.016	39	.004	.003	5	.002	32
9	90-99	83	.036	382	.034	.211	380	.117	1794
Total		2342		11127			1797		15382

TABLE VII[14]

[14] See Appendices B and E for source of information.

MARE ISLAND AND PEARL HARBOR GENERAL DMI STATISTICS

	% Std Stk in DMI 30 or more days	% Non Std Stk in DMI 30 or more days	Oldest in DMI (Julian)	Most Current in DMI (Julian)	% Std Stk On Order 30 or more days
Mare	90.6	95.2	2182	5090	---[15]
Pearl	90.6	---[15]	2235	5084	58.75

	Avg. Days Std Stk Outstdg	Std. Dev.	Avg Days Non Std. Stk Outstdg	Std Dev.	Avg Days in DMI	Std Dev.
Mare	---[15]	---[15]	---[15]	---[15]	681.62	353.94
Pearl	72.69	77.01	70.88	67.55	152.4	109.22

TABLE VIII[16]

[15] Data was not obtained.

[16] See Appendices B and E for source of information.

PEARL HARBOR PARTIAL FINE[17] FSG BREAKDOWN
COMPARISON TO GENERAL FSG-CAT BREAKDOWN
STD STK ON HAND

GENERAL BREAKDOWN				PARTIAL FINE	
Cat.	FSG	Freq	Rel Freq	Rel Freq	Freq
1	-19	739	.061	.067	678
2	20-29	721	.059	.066	669
3	30-39	782	.063	.073	739
4	40-49	3337	.272	.242	2435
5	50-59	5348	.435	.453	4563
6	60-69	724	.059	.059	603
7	70-79	112	.009	.010	103
8	80-89	59	.005	.003	37
9	90-99	460	.037	.027	271
		12282			10098

STD STOCK ON ORDER

1	-19	202	.051	.071	187
2	20-29	182	.046	.033	85
3	30-39	196	.049	.058	153
4	40-49	790	.198	.195	509
5	50-59	1737	.434	.446	1165
6	60-69	576	.144	.138	361
7	70-79	42	.011	.011	30
8	80-89	49	.012	.013	36
9	90-99	221	.055	.035	92
		3995			2618

TABLE IX[18]

[17]See Appendix C. Only 12,716 of the 16,277 records of standard stock items were analyzed for their FSG distribution. As can be seen there is very little difference between the two distributions (maximum difference of 3% occurs in category three with the rest being less than 2%). This fact did dispel some concern over possible duplication over part of the tape.

[18]See Appendices B and C for raw data.

MARE ISLAND/PEARL HARBOR RELATIVE FREQUENCIES

CAT	FSG[19]	MARE Non Std. Stk. On Hand	MARE Std. Stk. On Hand	PEARL[20] Std. Stk. On Hand	PEARL[20] Std. Stk. On Order
3	30	.002	.004	.010	.013
	31	.008	.011	.056	.037
	32	.0	0	0	0
	33	.0	0	0	0
	34	.011	.003	.005	.005
	35	--	.001	.002	.002
	36	0	0	0	0
	37	0	0	0	0
	38	0	0	0	0
	39	.001	.002	--	.002
4	40	.012	.008	.002	.003
	41	.002	.002	.016	.008
	42	.001	.001	.001	.003
	43	.005	.002	.059	.035
	44	.001	.001	.012	.010
	45	.008	.005	.008	.007
	46	--	0	.001	.002
	47	.512	.297	.096	.080
	48	.077	.021	.047	.047
	49	--	.002	--	.002
5	*50	.002	.002	0	0
	51	.003	.007	.002	.006
	52	--	0	--	--
	53	.139	.208	.276	.176
	54	--	0	0	0
	55	--	.001	--	.002
	56	.018	.023	.004	.006
	57	0	0	0	0
	58	.001	.002	.019	.071
	59	.027	.142	.152	.184

TABLE X[21]

[19]Those FSG's preceded by an asterisk are not identified as a legitimate FSG based on the DLSC cataloging pamphlet 38 published in 1964.

[20]Figures represent a sampling of 12,716 of the 16,277 records of standard stock items on order and on hand obtained from Pearl Harbor tape. Results agreed generally within 1% of the total run except for FSG 47 where there was a 3.7% difference. Although results of the total run would have given slightly closer results with Mare Island, the sampling was used to emphasize the similarity between Mare Island and Pear Harbor's distribution.

[21]See Appendices C and F for raw data used in this table and D for Pearl's total run. Dashes indicate an insignificant amount.

TABLE X (continued)

CAT	FSG[19]	MARE Non Std. Stk. On Hand	MARE Std. Stk. On Hand	PEARL[20] Std. Stk. On Hand	PEARL[20] Std. Stk. On Order
6	60	0	0	0	0
	61	.013	.011	.021	.056
	62	.001	.012	.005	.026
	63	.001	.001	.002	.001
	64	0	0	0	0
	65	0	0	0	0
	66	.032	.014	.027	.037
	67	0	0	0	.001
	68	.001	.002	.004	.016
	69	0	0	--	0
9	*90	.002	.002	0	0
	91	--	0	.003	.005
	92	0	0	0	0
	93	.012	.002	.004	.006
	94	0	0	0	0
	95	.101	.206	.020	.023
	96	--	0	--	--
	97	0	0	0	0
	98	0	0	0	0
	99	.001	0	--	0

MARE ISLAND/PEARL HARBOR
RELATIVE FREQUENCY DIFFERENCES
BETWEEN SELECTED ON HAND STD STK FSG'S

FSG	±2%	±5%	±7%	±10%	±15%	15%
30	1					
31		1				
34	1					
35	1					
39***	1					
40	1					
41	1					
42	1					
43			1			
44	1					
45	1					
46**	1					
47						1
48		1				
49***	1					
*50***	1					
51	1					
52**	1					
53			1			
55***	1					
56	1					
58	1					
59	1					
61	1					
62	1					
63	1					
66	1					
68	1					
69 **	1					
*90***	1					
91**	1					
93	1					
95						1
96**	1					
99	1					
Totals	29	2	2			2

TABLE XI[22]

* Identifies non recognized FSG's.

** Indicates none was on hand at Mare Island and a low or insignificant amount was on hand at Pearl Harbor.

*** Indicates none was on hand at Pearl Harbor and a low or insignificant amount was on hand at Mare Island.

[22] Comparisons are based on data from Table X.

One of the basic premises which the authors felt essential to the idea of utilizing DMI's as an alternate means of fulfilling a requirement was that the types of materials used, ordered, and held in DMI by the various shipyards would have a basic similarity. Another premise which would have to be satisfied in order to be able to seriously consider use of DMI in such a manner was that material held in DMI, generally, was not used immediately. Intuitively, both authors felt such conditions existed, however, were unable to explicitly state or obtain from historical records their extent.

As indicated earlier, to facilitate presentation of data, the FSG's were broken up into nine material categories. This procedure as a result makes it rather apparent from Table VII that there is a basic similarity between the relative frequencies of the nine material categories. There are, however, two significant differences which should be noted, namely, the use of standard and nonstandard stock items, and material category nine at these two shipyards. Wherein Mare Island's DMI consists primarily of nonstandard items, Pearl Harbor is the reverse. The difference is not as prominent in use of structural steel, etc. (FSG 95) which is the main ingredient of category nine. These differences are to be expected as a result of the type of work each yard is assigned. However, Mare Island in a sense is unusual in that it almost exclusively builds submarines. Nevertheless, shipyards dealing primarily in construction work will find it necessary to use more nonstandard materials, and the concept of construction immediately implies the use of greater quantities of steel (FSG 95). On the other hand, Pearl Harbor is

principally engaged in regular overhaul availabilities.[23] Although an overhaul shipyard, Pearl Harbor does have a similarity to Mare Island in that it does considerable work on submarines. This could, to an extent, bias data used from these shipyards to submarine work.

A factor which has not been raised, heretofore, is the variability of DMI distribution and investment. This element can quickly change and influence the distribution of material to a certain extent, depending on the ordering method at each yard and most certainly the line item value, which is affected by the type and quantity of material procured. In Table VII, both the distribution for "Total" and "Thirty (30) or More Days" show somewhat the same picture relatively unto themselves as between each other. However, no data is available to compare these distributions with other periods of the year. Some examples regarding DMI investment fluctuation are available historically and from personal experience which will be referred to briefly. In the case of Pearl Harbor's DMI investment, it is recalled that it fluctuated between one million and 1.5 million dollars, normally stabilizing at a little over one million dollars.[24] As shown in Table IV, it was approximately one million dollars on 30 June 1964. The program run by the authors analyzing Pearl's DMI showed approximately a two million dollar investment[25] as

[23]This is a term used by shipyards to identify a ship assigned to it for work which may be a regular overhaul, a restricted availability, or a technical availability.

[24]As a result of the Vietnam crisis, activity at Pearl Harbor, it is understood, has picked up measurably having direct influence on increasing DMI investment on the average to 1.5 million dollars or more.

[25]The March 1965 Financial and Operating Statement showed approximately a 1.5 million dollar investment. Reasons for this possible discrepancy were enumerated under Table V.

summarized in Table V. On the other hand Mare Island's DMI figure could conceivably vary as much as 2 million dollars over a period of a year or less. This fact was obtained in the course of conversation with personnel at Mare Island and is understandable considering one particular incident which occurred while on a research trip to that shipyard. The planners had over-ordered some nonstandard bar stock to the extent of $350,000. and wanted to turn it in. Generally the shop or planners will attempt to get this material picked up in shop stores so the Naval Industrial Fund won't lose any money (which it would if this material were excessed). If material is not picked up in shop stores, it would then be turned into DMI for further processing and where most certainly some negotiations to handle this material could be worked out. It would not take many of these instances, in addition to some sizeable bulk receipts, to increase DMI investment considerably. Up to this point, it is felt that in spite of DMI fluctuations, results from the general material runs and Table VII support to an extent our original premise.[26] To wit, a loose similarity exists between the types of standard stock material used at shipyards on a collective basis as obtained from arbitrarily grouping FSG's into nine categories. To further investigate this premise, a finer breakdown was made by FSG for five of the nine material categories, which is summarized in Tables X and XI.[27] It is to be noted that the program run for Pearl Harbor is on only 12,716 of the 16,277 standard stock records.

[26]See Appendices B and E.

[27]See Appendices C, D and F for raw data.

This was done to test whether the distribution would be approximately the same as the total run. In fact, this procedure had a two fold purpose, namely, if there was a duplication in the Pearl Harbor run, the authors felt it desirable to see if a partial run significantly altered any of the basic results, and secondly, if the results were satisfactory, use the results of this run in the comparison with Mare Islands fine breakdown in Tables X and XI. An added effect was desired which was to show that whatever findings were made, they would not have to be overly sensitive to sampling of the DMI. The comparisons made in Table XI were restricted to the material categories, which the authors felt from their experience, would contain those items most susceptible to creating material problems at a shipyard.

It was most gratifying to see that the similarity noticeable in the general groupings had a better correlation on inspection of the results of the breakdown by FSG. Referring to Table X, one can see a rather remarkable similarity between the relative frequencies of both yards standard stock material on hand. As shown in Table XI a clear majority of the FSG's were within $\pm 2\%$ of each other. However, it is also noted that several groups differed significantly, + 15%, namely FSG 47,[28] and 95.[29] Other FSG's which differed greater than 2% were FSG 31,[30] 43,[31] 48,[32] and 53.[33] However, in these cases Pearl Harbor had the larger

[28]Pipe, tubing, hose, and fittings.

[29]Metal bars, Sheets, and Shapes.

[30]Bearings.

[31]Pumps and Compressors.

[32]Valves.

[33]Hardware and Abrasives.

relative frequencies. In both cases it is felt that these differences are most likely peculiar to the type of work in which a yard is engaged. As previously mentioned, Pearl Harbor, being a repair shipyard, will probably have a more even distribution of types of material used even though a great deal of the work may, in fact, be done on submarines. Peculiarly characteristic of a construction shipyard is the high use of bulk steel, FSG 95, and in Mare Island's case, considerable use of fittings, etc., FSG 47. The relative weighting of materials used in surface ship construction most likely would be different possibly in the area of electronics equipment and components. Nevertheless, based on results obtained from Pearl Harbor and Mare Island, it seems that there is a likelihood that the DMI FSG distributions will have considerable similarity except possibly in the FSG's noted.

Since a FSG contains a number of different FSC's which in turn are broken down into FSN's, it is hard to say how well this similarity in distribution would stand up especially at the stock number level. There is no doubt that large disparities would occur; however, there are a number of jobs which repair shipyards accomplish wherein material requirements, especially in the standard stock area, are identical. The particular type of work the authors have in mind is the accomplishment of ship alterations (SHIPALTS).

Up to this point, discussion has been primarily limited to on hand standard stock items since this was the only available data common to both shipyards in a form suitable to make a comparison. It was the authors' intention that having shown a relationship in this area, relationships with regard to standard

stock on order and nonstandard stock on order and on hand could be considered under this basic premise of similarity of distribution.

Referring back again to Table VII and in particular to the Pearl Harbor standard stock on order portions, there again seems to be a similarity in the distributions of standard stock on hand and on order. The most prominent differences being between material categories four and six. Material in these categories are quite sensitive to work emphasis changes in the yard which may explain the differences found. Materials in category four consist of such items as pumps, compressors, pipe, fittings, and valves, while category six material is of an electrical nature. As Table X shows, the similarity between FSG on order and on hand seems quite close; but collectively, differences are more noticeable. Nevertheless, there is a similarity between standard stock FSG's on order and on hand. The concept which it is intended to convey is the same as that forwarded for the use of standard stock at Mare Island and Pearl Harbor with one further stipulation. Namely, if there is a basic similarity between standard stock relative frequencies for on hand DMI material at two shipyards, there may also exist a similar basic relationship between relative frequencies of standard stock material on order at these two shipyards. This would possibly further imply extension to other yards with the exception of material noted as being peculiar to the yard's mission.

Since Pearl Harbor does not identify its nonstandard material to FSG's and FSC's as Mare Island, no common base exists for comparison between the two shipyards. This fact makes it necessary

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

to make an outright assumption that there exists a possibility that there may be a similarity between the distribution of nonstandard material on hand and on order at shipyards. In a certain sense, this assumption may not be entirely unreasonable in that nonstandard as the term implies is not a normally used item and complements supply system material, namely, standard stock items. In the case of shipyards doing construction work, there is a heavy reliance on the use of this material. This is due to the fact that at the time of ship construction, the supply system either has not been able to respond to the change in technology which may have been required to build the ship, or that the material may be of such a specialized nature that the use of these particular items over a period of time would not justify stocking in the 'system.' However, problems in procurement of nonstandard material from the authors' experience and observation is not the exclusive territory of construction shipyards.[34] Repair yards, as well as construction yards are extremely likely to experience similar material problems and over identical nonstandard material. The material area in which one author recalls considerable nonstandard ordering activity and problems at Pearl Harbor, in comparison with other materials being procured, was pipe, tubing, fittings, and valves. These types of material are contained in material category four. It is noted that nonstandard material in this category is also used quite extensively at Mare

[34]This cannot be substantiated or quantified by the authors with documentation, however, recalling conversation with personnel at Mare Island, a number of the nonstandard items that they were experiencing problems with seemed identical to material ordered by Pearl Harbor a year earlier.

Island. Experiences as to Pearl Harbor's activity regarding other nonstandard items is limited to the recollection that a fair amount of purchase business was also devoted to electrical/electronic components, part of material categories four and five. This, however, includes purchase of immediate requirements of standard stock material not available from local stock.

The other premise which the authors felt had to be satisfied, as indicated earlier, was that material is not necessarily used immediately upon receipt into DMI. This fact is born out by the results summarized in Table VIII. Note that the average age of material in Pearl Harbor's DMI, approximately 152 days, is only $\frac{1}{4}$ the age of Mare Island's DMI average line item age, approximately 681 days. This is a natural reflection of the type of work each shipyard is engaged in. Repair overhauls generally last from three to four months, whereas the construction cycle will run from one to four years. As evidenced from the standard deviations of these averages, 109 and 354 days for Pearl Harbor and Mare Island respectively, and consequently the requisition date range for both yards, there is quite an age spread. This phenomena is explained by the ordering method followed at most shipyards which the authors feel amounts to a three stage process. The first stage involves early ordering of known material requirements which are derived from plans and previous experience in similar jobs. This occurs theoretically four to five months in advance of the arrival of a ship for overhaul, and probably even longer in the case of construction work. The second stage of ordering occurs when a specific job order is written which identifies to the shop work which is to be accomplished. Ordering

at this stage covers conditions which were dependent on finalization of work to be accomplished. Usually at this stage the ship is in the shipyard. The third stage of ordering covers emergency requirements or situations which were unforeseen at earlier ordering stages.

The average time standard and nonstandard material are on order at Pearl Harbor is shown in Table VIII. The results seem remarkably similar, approximately 70 days. However, these figures may be misleading as to how serious it actually is to have a requisition outstanding on the average of approximately 70 days. A more revealing figure would be obtained if the figures were broken down by priority. Although the DMI tape did provide for indicating priorities, this field was found to be blank, as were the fields identifying controlling and critical items. A factor which may have inflated the standard stock time is that Pearl Harbor will reorder material under a higher priority as the need for the material increases, and let the original item come in under its initial priority. As can be seen, this procedure would also inflate the standard stock on order figure. Although the bulk of ordering done at Pearl Harbor is priority seven (7),[35] which theoretically involves three day delivery per UMIPS [59], it is understood that many of these requisitions have been reordered under higher priorities. Hence, we are unable to fully

[35]This policy even applies to early order of material due to bad experiences with priority fourteen (14) delivery. Delivery from CONUS was usually thought in terms of 15 to 30 days for priority 07 requisitions.

evaluate this affect on the standard stock outstanding figure.[36] One factor which may cause a difference in the nonstandard order time is the quantity and/or uniqueness of material contracted. A number of these type of purchases can cause a drastic increase in the time on order figure. This factor would probably have more effect on Mare Island order times due to bulk requirements inherent in construction/conversion work.

The reasons for trying to establish the possible existence of a similarity between material distributions and aging of material in DMI's at Mare Island and Pearl Harbor were two fold. First, if this possibility seems reasonable there is a chance this material would be available for limited utilization to the more mutual advantage of all shipyards and the Navy. To accomplish this purpose under the system proposed in this paper, a central data bank is required. As a means for determining the size of such a bank, it is necessary to have an approximate idea as to the number of line items which might be involved. Ergo, the second purpose of establishing the existence of similarity is to generalize these distributions in Table VII to all shipyards as to their work mission shown in Table IV.

The means for equating the distributions in Table VII to line item values for each shipyard will be accomplished by assuming similar frequency distributions between shipyards identified as repair and construction. Due to a lack of information in the distribution of standard stock and nonstandard stock on order for

[36] See Appendices C and D for a breakdown by FSG. Results are further broken down into 30 day increments beginning with 60 days outstanding through 179 days outstanding.

construction shipyards, and a similar lack of distribution information available on nonstandard stock on hand and on order for repair shipyards, considerable generalizations will be required. They are as follows:

1. Mare Island's nonstandard material category relative frequency distribution will be assumed to approximate both a construction yard's and a repair yard's nonstandard stock on hand and on order distribution.

2. Pearl Harbor's standard stock on order material relative frequency distribution will be assumed to coincide with that of a construction yard as well as for a repair yard.

3. The line item value for standard and nonstandard stock items developed from the Pearl Harbor and Mare Island DMI tapes will hold similarly with all repair and construction yards respectively.

4. The ratio of standard and nonstandard line items on order to total line items on order is directly proportional to total line items on hand divided by a ratio of total line items on hand to line items on order and holds for all shipyards.

5. Statistics will be based on the 30 June 1964 investment figures shown in Table IV.

The authors do not feel the above assumptions are entirely unreasonable in light of findings which were discussed earlier. Due to the extent of generalization made, we will treat this projection with no more significance than an idea of the possible volume of information a central data bank may have to contain under the system proposed by this paper. A finer definition of this figure could be obtained given more time. Material categories to

be considered in our projections are three, four, five, six, and nine. The criteria for limiting the projection to these categories was the fact that these seem to be the more significant material categories at Pearl Harbor and Mare Island in terms of quantity and range of time on hand or on order.[37] Additionally, they contain FSG's of material we feel most likely to cause a significant supply problem at one time or another in a shipyard. We have purposely not attempted to single out particular FSG's from these categories as unusually pertinent except to acknowledge their existence, i.e., 31, 34, 41, 43, 47, 48, 53, 58, 59, 61, 66, 95.[38] These would require special screening into a more pertinent FSC and possibly for some categories by specific stock number. Such a screening it is felt would reduce projected totals

[37]See Appendices C, D and F.

[38]The FSG's represent the following materials respectively:

Bearings,

Metal Working Machinery,

Refrigeration and Air Conditioning Equipment,

Pumps and Compressors,

Pipe, Tubing, Hose, and Fittings,

Valves,

Hardware and Abrasives,

Communications Equipment,

Electrical and Electronic Equipment Components,

Electric Wire and Power and Distribution Equipment,

Instruments and Laboratory Components, and

Metal Bars, Sheets and Shapes.

by at least 25%.[39] Also consider the fact that if only DMI items 30 or more days old were considered in order to reduce transaction reporting which most assuredly would be required to keep the proposed data bank current, standard stock totals might be reduced approximately 10% and nonstandard totals would be reduced approximately 5%.[40]

To represent the relative frequencies developed in Table VII in a convenient form for computation, the relative frequencies from this Table were fitted to a curve which amounts in effect to a probability density function. Although an exact fit could not be obtained, it was found with one exception, that a six degree polynomial gave the best fit with an average root mean square error of approximately 0.10. The exception was Mare Island's nonstandard distribution which had a root mean square error of .23. The effect this error had on our total shipyard projections was to inflate all values between 10 and 11%.

In that these projections are the result of considerable generalization, it was decided that minute accuracy at this stage would be pointless in that the authors primarily were interested in an idea as to the quantity of information involved. Furthermore, the use of an inflated figure would be a better test of our system. However, for information purposes, results using the exact

[39]This is to a certain extent conjecture on the part of the authors, but not totally without basis. Some groups such as 53 (hardware) are of a high volume nature but common enough to manufacture or buy locally. FSG 59 may be considered in a similar manner. It can be seen that a careful review of these groups would reduce projected quantities considerably.

[40]See Tables VII and VIII.

relative frequencies in generating this projection have also been included for purposes of continuity.[41]

The basic program for generating the curves used in this paper was provided by Lt(jg) Parry of the Operations Analysis Department. Shown below are the equations generated by this program.[42]

Pearl Harbor Standard Stock on Hand:

$$f_{PH}(X_{ss}) = -1.70653 + 4.0054X - 3.25048X^2 + 1.22228X^3 - .22719X^4 + .0202692X^5 - 000693106X^6$$

Pearl Harbor Nonstandard Stock On Order:

$$f_{PH}(X_{ns}) = -2.08437 + 4.70493X - 3.68746X^2 + 1.33881X^3 - .241359X^4 + .0209862X^5 - .000702191X^6$$

Mare Island Standard Stock On Hand:

$$f_{MI}(X_{ss}) = -1.10723 + 2.67529X - 2.32742X^2 + .927683X^3 - .179074X^4 + .0163395X^5 - 000565342X^6$$

Mare Island Nonstandard Stock On Hand:

$$f_{MI}(X_{ns}) = .928683 - - 1.45905X + .569187X^2 - .0029664X^3 - .0287674X^4 + .00445182X^5 - .000199009X^6.$$

Presented in subsequent paragraphs is the rationale used to make the shipyard DMI projections.

Initially, ratios were developed between standard stock and nonstandard stock investment to total investment.[43]

[41]See Table XIII.

[42]Relative frequencies used were obtained from Table VIIA. See Appendix G for program and output. Also shown is a fit for 5 degrees.

[43]Mare Island and Pearl Harbor figures were obtained from Tables V and VI.

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[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

MARE ISLAND

$$f_{MI}(R_{ss}) = \text{Ratio (Std. Stk)} = \frac{\$\text{Std Stk}}{\$\text{Total}} = \frac{\$476,550.}{\$5,908,936.}$$

$$f_{MI}(R_{ns}) = \text{Ratio (Nonstd Stk)} = \frac{\$\text{Nonstd Stk}}{\$\text{Total}} = \frac{\$5,432,386.}{\$5,908,936.}$$

PEARL HARBOR

$$f_{PH}(R_{ss}) = \text{Ratio (Std. Stk)} = \frac{\$\text{Std. Stk}}{\$\text{Total}} = \frac{\$923,069.47}{\$2,130,980.65}$$

$$f_{PH}(R_{ns}) = \text{Ratio (Nonstd. Stk)} = \frac{\$\text{Nonstd Stk}}{\$\text{Total}} = \frac{\$1,207,911.28}{\$2,130,980.65}.$$

Utilizing 30 June 1964 DMI investment figures shown in Table IV, hypothetical standard and nonstandard stock DMI money value investments for all shipyard DMI's were computed. DMI[44](I) = $ DMI investment at a designated shipyard, I.

CONSTRUCTION YARDS

DSFA (I) = $ Investment Std Stk = $f_{MI}(R_{ss})$ * DMI (I)

DNFA (I) = $ Investment Nonstd Stk = $f_{MI}(R_{ns})$ * DMI (I)

REPAIR YARDS

DSFA (I) = $ Investment Std Stk = $f_{PH}(R_{ss})$ * DMI (I)

DNFA (I) = $ Investment Nonstd Stk = $f_{PH}(R_{ns})$ * DMI (I)

Line items of standard stock and nonstandard were generated for all shipyards as shown below.[45]

CONSTRUCTION YARDS

ANSTD (I) = Line Items Std Stk = DSFA(I)/$238.99

ANNST (I) = Line Items Nonstd Stk = DNFA(I)/$335.77

[44]Figures for this constant were obtained from Table IV.

[45]Mare Island and Pearl Harbor average money value figures were obtained from Tables V and VI.

REPAIR YARDS

ANSTD (I) = Line Items Std Stk = DSFA(I)/\$75.16

ANNST (I) = Line Items Nonstd Stk = DNFA(I)/\$550.05

Utilizing probability density functions,[46] figures for line items of standard and nonstandard stock on hand for specified material categories X were generated and accumulated for each shipyard. As indicated earlier, the Mare Island nonstandard stock on hand distribution is to be used for all shipyards.

CONSTRUCTION YARDS

STEMP (II,I) = Line Items Std Stk in Category X = $f_{MI}(X_{ss})$ *ANSTD(I)

TEM (II,I) = Line Items Nonstd Stk in Category X = $f_{MI}(X_{ss})$ *ANNST(I)

ACT (II,I) = Accumulation of Line Items for each yard.

REPAIR YARDS

STEMP (II,I) = Line Items Std Stk in Category X = $f_{PH}(X_{ss})$ *ANSTD(I)

TEM (II,I) = Line Items Nonstd Stk in Category X = $f_{PH}(X_{ns})$ *ANNST(I)

ACT (II,I) = Accumulation of Line Items for each yard.

A relationship was established for generating line items on order at each shipyard. Since data was only available from Pearl Harbor[47] in this area, Pearl Harbor's ratios were used for all yards.

Ratio_{PH} = Total Line Items On Hand/Total Line Items On Order

= 14,478/7999 = 1.81

OSTD (I) = Line Items Std Stk Outstanding = ((Total Line Items On Hand)/Ratio_{PH})* Line Item Std Stk Outstanding/Total Line Items Outstanding.

[46] See Appendix G for programs generating curves.

[47] Figures were obtained from Table V.

OSTD (I) = ((ANSTD(I) + ANNST(I))/1.81) * 3999/7999

ONST (I) = Line Items Nonstd Stk Outstanding

= ((Total Line Items On Hand)/Ratio_{PH}) * Line Item Std Stk Outstanding/Total Line Item Outstanding

ONST (I) = ((ANSTD(I) + ANNST (I))/1.81) * 4004/7999

Utilizing probability density functions for Pearl Harbor standard stock on order and Mare Island nonstandard stock on hand, figures for line items on order at each shipyard were generated. Use of the Mare Island nonstandard distribution was necessary due to lack of other information.

CONSTRUCTION AND REPAIR YARDS

STEMP (II,I) = Line Items Std Stk Outstanding Category X

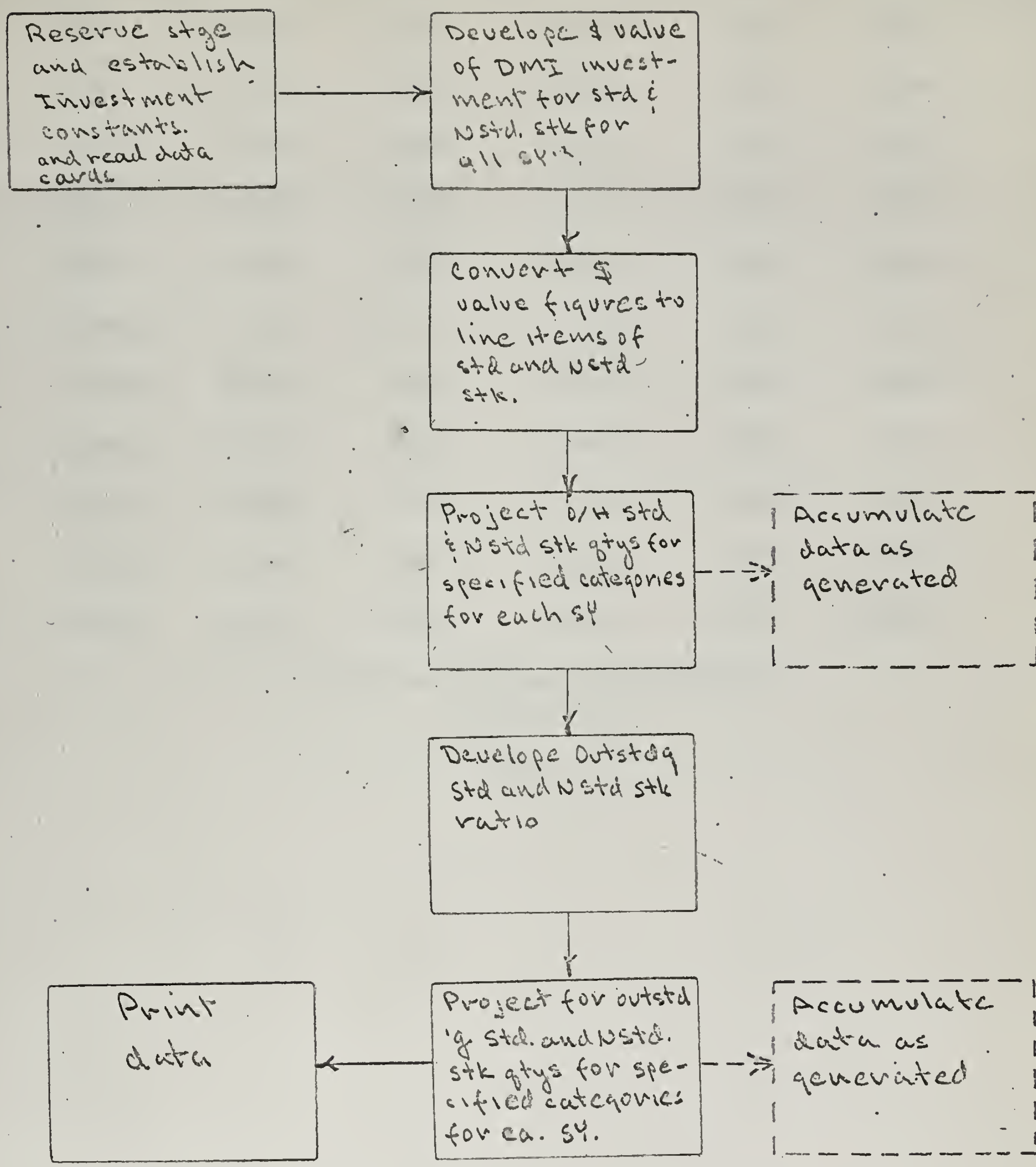
= $f_{PH}(X_{ss})$ * OSTD(I)

TEM (II,I) = Line Items Nonstd Stk Outstanding Category X

= $f_{MI}(X_{ns})$ * ONST(I)

ACT (II,I) = Accumulation of Line Items for each yard.

Shown on the following pages is the program flow for the DMI projection program and results of the DMI projection.



DMI MATERIAL PROJECTION PROGRAM[48]

FIGURE 9

[48] See Appendices H and I for program. Outputs are shown in Tables XII and XIII.

STD	O/H STD	O/H NSTD	ORDR STD	ORD NSTD	TOTL O/H	TOTAL ORD
PTSMH	3292	27169	6573	8440	30461	15013
BSN	997	8227	1990	2556	9224	4546
NYK	1732	14292	3458	4440	16024	7898
PHILA	1078	8894	2152	2763	9972	4915
BREM	1761	14537	3517	4516	16298	8033
MARE	2970	24513	5931	7615	27484	13546
LBEACH	323	68	97	125	391	222
SFRAN	19287	4091	5810	7459	23379	13269
NORVA	4977	1056	1499	1925	6032	3424
CHASN	5368	1139	1617	2076	6507	3693
PEARL	5743	1218	1730	2221	6962	3951
TOTAL	47529	105205	34374	44135	152734	78509

SHIPYARD ON HAND/ON ORDER PROJECTION
USING CURVES

TABLE XII[49]

[49]Projections were generated utilizing curves developed by program in Appendix H. Figures shown represent line items.

SYD	O/H STD	O/H NSTD	ORDER STD	ORD NSTD	TOTL O/H	TOTAL ORD
PTSMH	3061	24783	6402	7698	27843	14100
BSN	927	7504	1939	2331	8431	4270
NYK	1610	13037	3368	4050	14647	7418
PHILA	1002	8113	2096	2520	9115	4616
BREM	1638	13260	3425	4119	14897	7544
MARE	2761	22360	5776	6946	25121	12722
LBEACH	304	62	95	114	367	208
SFRAN	18202	3732	5658	6804	21934	12463
NORVA	4697	963	1460	1756	5659	3216
CHASN	5066	1039	1575	1894	6104	3468
PEARL	5420	1111	1685	2026	6532	3711
TOTAL	44687	95964	33479	40258	140651	73737

SHIPYARD ON HAND/ON ORDER PROJECTIONS
USING EXACT RELATIVE FREQUENCIES

TABLE XIII[50]

[50]Projections were generated utilizing relative frequencies shown in Table VII. Figures shown represent line items. See Appendix I for program.

SUMMARY

The authors felt that two principle ideas had to be established in order to determine whether utilization of DMI on a broader and more formal base would be feasible. One, that materials used by shipyards were basically similar, thereby, implying a possible alternate source of supply for urgent shipyard requirements. Secondly, that this material, if turnover was slow, could be stored in a central data bank for shipyards to query in order to fill emergency requirements.

Initially it was thought that data would be available historically and be used as a basis for a study of the actual workings of a proposed system utilizing these DMI's as an alternate supply source for shipyards. As it turned out no information was readily available and consequently the bulk of the research time available was spent in developing the problem and establishing these ideas.

To investigate the idea of similarity in types of materials used and their age, on hand or outstanding, magnetic tapes were obtained from Mare Island and Pearl Harbor and analyzed--this was not accomplished without experiencing considerable problems in screening out pertinent data. To facilitate the analysis of material distribution, the various FSG's were initially combined into nine material categories. Results, except for category nine, showed a promising similarity, $\pm$ 5%, between the relative frequencies of on hand standard stocks between Mare Island and Pearl Harbor's. Due to the difference in their work mission, this was to be expected. Another significant difference was that where Pearl Harbor's on hand DMI consisted primarily of standard stock

items, Mare Island was almost the exact reverse of this. Since Mare Island does maintain some system stock in addition to considerable Shop Store stock these facts could conceivably lower the amount of standard stock held in DMI. Nevertheless, being a construction shipyard, Mare Island would have cause for use of considerable quantities of nonstandard material. Since Pearl Harbor does not identify its nonstandard material, there was no means to directly compare distributions of this type of material. As a result, it was necessary to assume that if there was a similarity in standard materials used there might be a similar relationship with regard to nonstandard material. It was noted that Mare Island's high use of category four material, i.e., tubing, fittings, valves, etc., lay in the fact that this is a primary ingredient in current submarine work. From past experience this was also observed at Pearl Harbor, however, the extent relative to use of other nonstandard materials cannot be quantified.

The idea of similarity was further pursued by analyzing the relative frequencies between the shipyards for selected FSG's. Here it was seen that there was remarkable agreement between individual relative frequencies of FSG's selected for special review in spite of local fluctuations. The most noticeable differences were between materials which the authors consider peculiarly characteristic of the shipyard's mission. The authors feel therefore, that there is reasonable evidence indicating a similarity between the distribution of on hand DMI standard stock between shipyards. Similar statements with regards to standard stock material on order and nonstandard stock material on hand and on order cannot be made with the same assurance due to lack of

confirming data. However, it does not seem unreasonable to believe that such conditions might also exist. In fact, it is the opinion of the authors that there is a greater likelihood of basic similarity between shipyards in these areas than not.

The question at this point is, how pertinent is having identical or similar frequency distributions? The immediate implication is that if material in a particular FSG is held in DMI, there is a possibility that one of the items in this group of materials may satisfy another shipyard's requirements. Due to the abstractness of this approach it would be pointless to say that the closer the agreement between frequency of use of a particular FSG between shipyards, the greater the probability these items will be identical. Depending on one's outlook this could be answered either way. Probably more reasonable would be that the greater the relative frequency of the holding yard regarding a particular FSG, the greater likelihood a desired item may be available in this FSG. Further statements regarding the significance of similar FSG material distribution at shipyards would require study at both the FSG and stock number level. Results, however, at the FSG level as shown in this paper, do seem to provide a reasonable base for lack of better information for projection purposes between shipyards.

The other idea which the authors were interested in was age of material in DMI. Results showed Pearl Harbor DMI material as having an average age of 152 days with a standard deviation of 109 days and Mare Island material with an average of 681 days with a 353 day standard deviation. The age difference is as it should be considering the difference in work each shipyard is engaged in.

The spread, although large, is understandable when one considers the length of time a ship will be in the various shipyards and what was described as the three stage ordering process.

In order to get an idea as to the number of line items of information which might be contained in a central data bank, extensive use was made of the general similarity found to exist between DMI standard stock on hand at Mare Island and Pearl Harbor. Very good agreement was found to exist between FSG's in material categories three, four, five, six and nine except for noted differences attributed to the shipyard work mission, repair or construction. As a result of the general similarity found in standard stock a generalized assumption was made regarding the possible distributions of standard stock outstanding and non-standard stock on hand and on order for all yards. It is recognized that this would automatically introduce errors for those material categories which would be peculiar to a yard's work mission. Another area contributing to the error in our projection is distortion created by local work emphasis. Therefore, as a result of the extensive generalizations assumed, the projection made can be only considered a candidate at best for the upper bound for the proposed system. Due to the collective approach to projecting possible information needs, intelligent screening most likely could reduce our projection figure considerably. For purposes of the remainder of this paper, we will consider the totals shown in Table XII as the basic statistics from which our system will be developed.

As a final comment, it was noted that there was a considerable difference between money values generated by our programs and that

reported by the shipyards in their quarterly report. Most of the comments regarding this matter took the position that these differences were probably created by the authors in some manner. There may be equal cause to question the shipyards. The area of DMI, how it is used and how material is accounted for, reported, and most important how closely are these precepts followed and policed; it is felt would obtain some interesting results if investigated. This last comment is not directed at any shipyard in particular, but at all shipyards collectively.

CHAPTER IV

THE SYSTEM--PRESENT AND PROPOSED

With the technological improvement of computer hardware and the increasing awareness of management to the value of information, considerable attention is and will continue to be given to the development, implementation, and improvement of Management Information Systems (MIS). The range of information which can be made available to the manager and the manner in which this information can be used has virtually made present large scale systems obsolete. As far back as 1959 the potential of computers in Navy logistics and business administration was recognized as described in stage 5 of the general plan for increased use of computers [33]. The BuSanda's interpretation of this instruction was the Uniform Automatic Data Processing System (UADPS) which has just recently been implemented. The significant aspect of BuSanda's program is the mass use of random access storage which was felt necessary to assure a maximum degree of speed in response to customer and management needs. [59] Extensive use is also made of interconnected data communication circuits between supply echelons of the military services, namely, AUTODIN.[1] The BuShips' approach to this area of automation on the other hand has not been quite as dramatic. Its initial approach was to encourage the installation and use of ADPS in shipyards. [55] As a result, each shipyard developed its own system. The difficulty the authors had in analyzing the DMI tapes from Pearl Harbor and Mare Island serves as an excellent example of the autonomy

[1] AUTODIN stands for Automatic Digital Information Network. This system is world-wide in scope and is an integral part of the DOD communications network.

each yard enjoyed. Other manifestations of this splintered shipyard information system was the void of comparable data between shipyards. In some cases this may be a result of having the information, but not knowing how or where to get it. The BuShips recognizing the need for more guidance in this area has since launched its own management information program appropriately called the BuShips MIS program.

Probably the most significant improvement the BuShips MIS program provides is the standardization of reports throughout all shipyards. This, of course, is the basis of a MIS. However, the BuShips primary interest in the initial implementation of their MIS was in production planning and control and cost accounting. The area of inventory control was recognized as an area to be looked into at a later date. There was a determination made that shipyards supporting supply operations primarily oriented to non-industrial support would require random access equipment capability [55]. As for the use of random access equipment at shipyards primarily oriented to industrial supply support, the decision was to be left pending the effect of MILSTRIP on the internal shipyard supply system.

Although the system proposed below utilizes tape limited computer configurations at each shipyard, there is a direct implication that random access equipment would be more desirable. In fact, the use of random access equipment would open the door to such concepts as "real time" systems, as used by the aircraft industry. This, however, is an area worthy of a thesis itself and will not be further investigated.

As indicated above, primary emphasis of the BuShips MIS was in

the production planning and control and cost accounting systems. Although the system proposed by this paper pertains to a form of inventory control, basic information inputs to and statistical outputs from the cost accounting system with some modification will serve as the basis for the proposed system. In effect, the authors perceive the proposed integrated system as a modular extension of the formally developed BuShips MIS system.

As the term "integrated material system" implies, the proposed system means to provide more central guidance of and mutual cooperation between individual shipyards than is presently being experienced in the area of material supply. Conventionally, one would interpret this to apply to system stock, i.e., stock and appropriation account material. However, the authors mean to carry this into a heretofore formally "untapped" area, namely, DMI. In order to accomplish this, it will be necessary to provide a means for storing DMI information in a central location, keeping it current, and interrogating it for purposes of redistributing material to eligible yards in a systematic manner. Use of this means of supply will be limited to emergency requirements which cannot be satisfied in timely fashion by the system or local purchase.

Further extension of this concept for requirements not of an urgent nature is felt to be unfeasible due to the fact that this material has been ordered for a specific job by the holding shipyard. The ramifications of indiscriminate use of this facility would without a doubt, cause serious chain effect scheduling problems. Despite problems which might be encountered in this system, it has merits which cannot be ignored. Unfortunately, trying to compare the

costs of this system with the advantages it may gain assumes fantastic proportions. For instance, what is the cost of not having material on time or missing a scheduled date? What is the cost of problems developed by this system which would not otherwise have occurred? These problems are perplexing and frustrating, but well worth further study.

Some of the more immediate assumptions which this system will be based on are the following:

1. It is assumed that the Late Material Report (S-5) [59] can be modified to provide on a weekly or biweekly basis the 30 DAY TRANSACTION CARDS and CHANGE CARDS as depicted in Figure 14 and in the formats described in Table XIV. Information which would have to be provided in addition to that already stated is the work category code, the document number, and the accounting number of the ship as described in Table XIV. The document number should be available in the DMI master tape, however, the work category and ships accounting number would have to be coded additionally at the time of requisition preparation. Although the stock number is provided as well as nomenclature on the above S-5 run, it's to be assumed that a stock number for nonstandard material can also be provided. Local assignment of stock numbers to non-standard items is provided for by the MIS [57]; however, it is limited to identifying material to a Federal Supply Class and a locally assigned serial number. Under this proposal it is assumed that a more universally recognized number can be assigned, which is discussed earlier in the paper. The authors have allotted a maximum of 64 card columns for this purpose as shown in Table XIV. Flags which are to be placed on various types of transactions as

shown on Figures 14 and 15 are considered programmable from information on the DMI master tapes.

2. It is assumed that as a key product of the DMI Issue Run,[2] the run depicted in Figure 15 can be accomplished, thus, generating a DELETE CARD in the format shown in Table XIV.

3. It is assumed that card formats can be used as described in Table XIV. The authors do not know whether DSA would approve of this, however, these cards are to be strictly for use between the BuShips and the shipyards. This in itself may be disagreeable, namely, creation of another supply system. Time has not been taken to develop particular codes for document identifiers and challenge investigations, since it was felt that this could easily be developed at a later date. Also with regard to card format is the use of trailer cards. This, of course, automatically increases volume and the possibility of lost cards, however, it is necessary to provide for space to identify nonstandard material. Were it possible to identify nonstandard material in 21 card columns, the need for trailer cards could be completely eliminated. Nevertheless, where possible MILSTRIP formats were followed. The card formats suggested are by no means limited to those shown, but it was felt best to standardize them as much as possible for use in the proposed system.

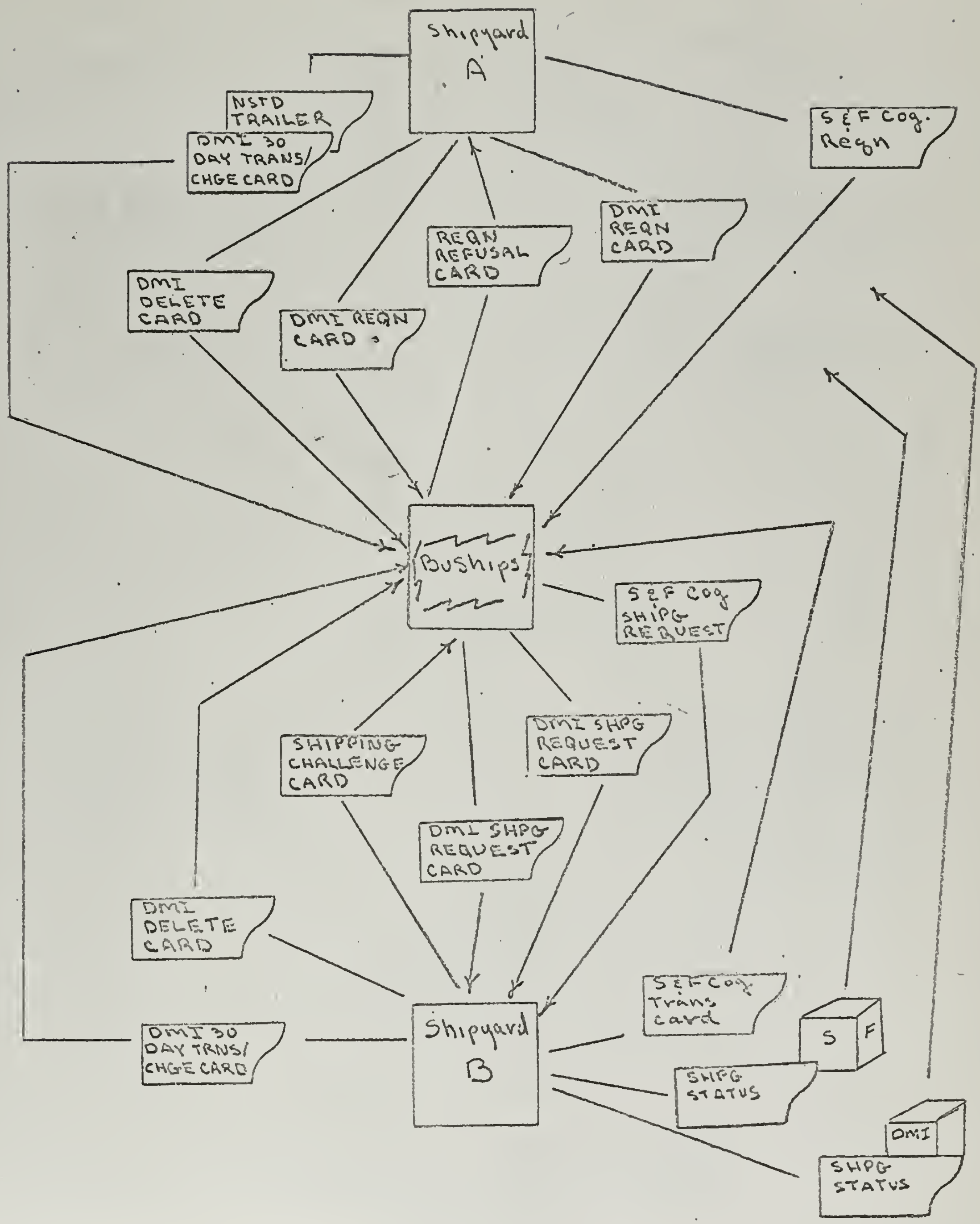
4. Possibly one of the most important tools of this system is the decision function factor (f_{DEC}) which the authors hypothetically developed. It is assumed that a factor can be developed

[2]The authors are aware that this is done but do not know the exact frequency or run number, however; it is felt this run is accomplished on a daily basis.

from the work category code and date material is required for a job. The value of the decision factor lies in its complete unbiasedness, consequently, this is the key to the proposed automated system. Without a consistent and unbiased method of decision making, inconsistent results may be obtained to the complete frustration of whatever advantages the system may have to offer.

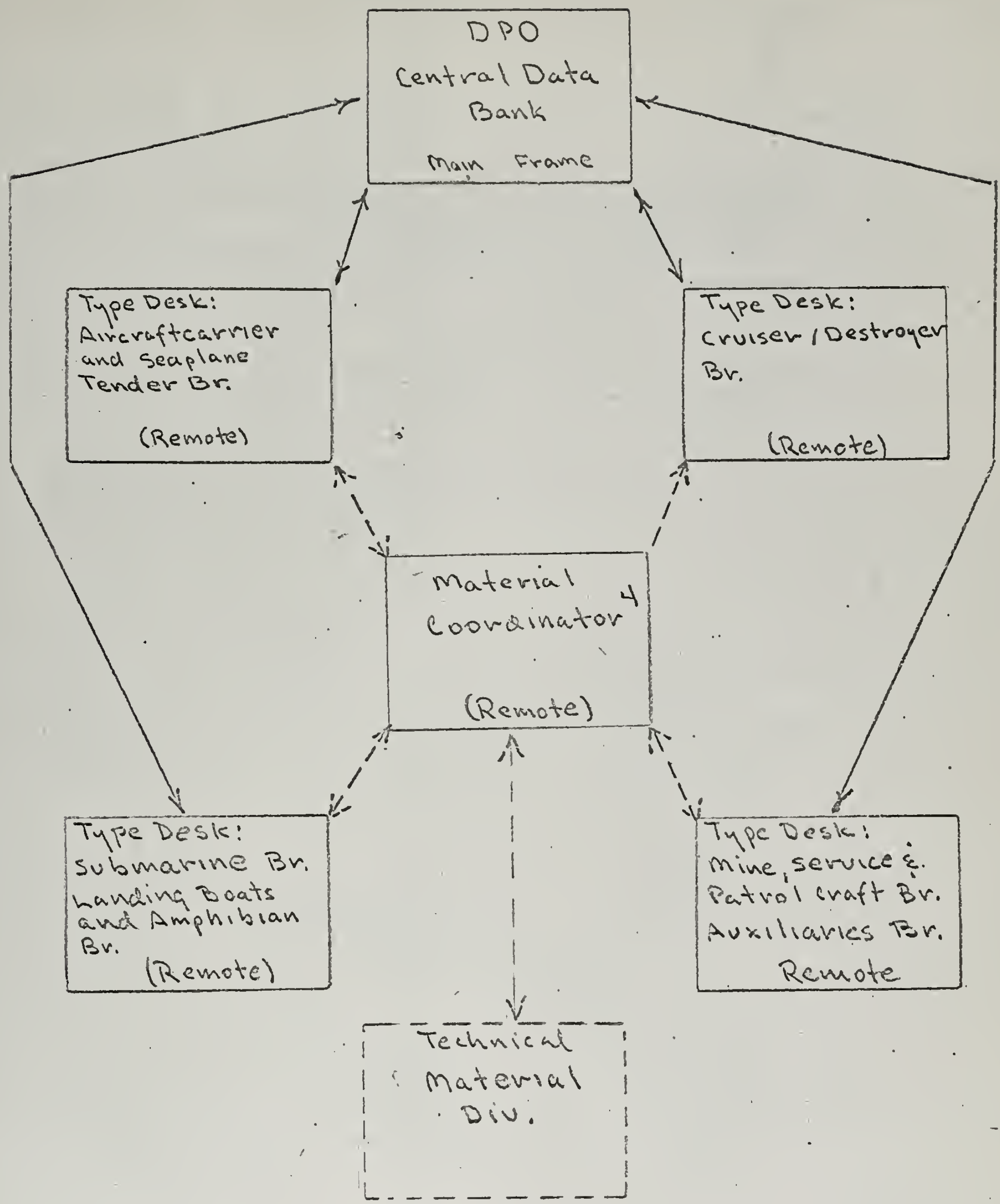
Although discussion has been devoted primarily to the DMI applications, it is also proposed that 'F' and 'S'' cognizance items, and other BuShips' logistics programs be placed in the random access central data bank. Presently, this information is on magnetic tape in the BuShips. It is understood that 'F' and 'S' cognizance items are updated at present every other day.

In developing the proposed system the headquarters and the field activity's viewpoint were taken into consideration. Only through central guidance and timely status information can an integrated material system be intelligently approached. The key to this is the computer and the rapid logistical communications network provided by AUTODIN. Described in Figures 10 through 16 and Table XIV are the more significant parts of the proposed system. It is to be a fully automated system, with a random access storage central data bank for DMI and Bureau controlled material; and a direct communication interface between core storage and the AUTODIN network.



INTEGRATED BUSHIPS SYSTEM

FIGURE 10

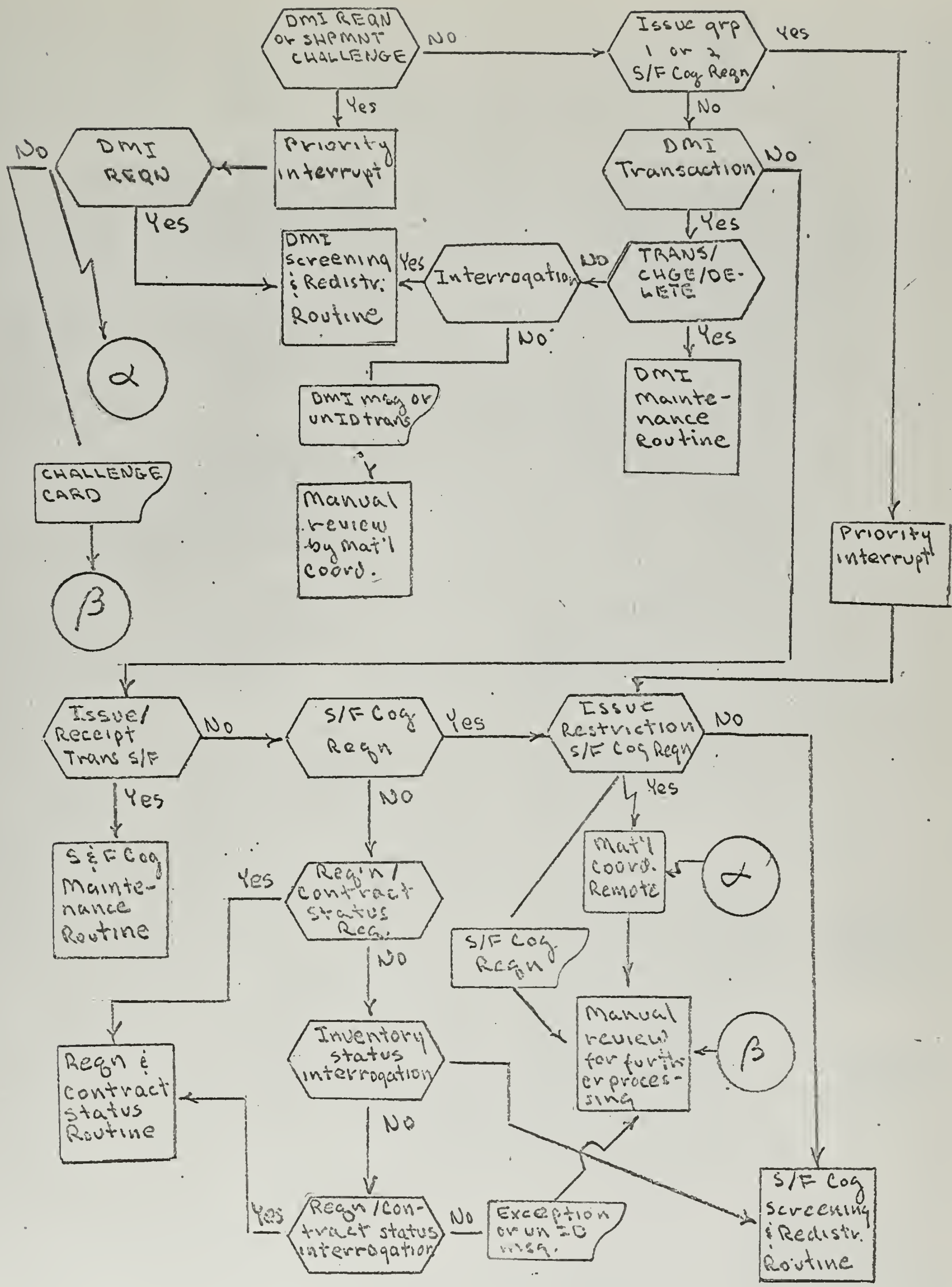


BUSHIPS INTERNAL COMMUNICATIONS[3]

FIGURE 11

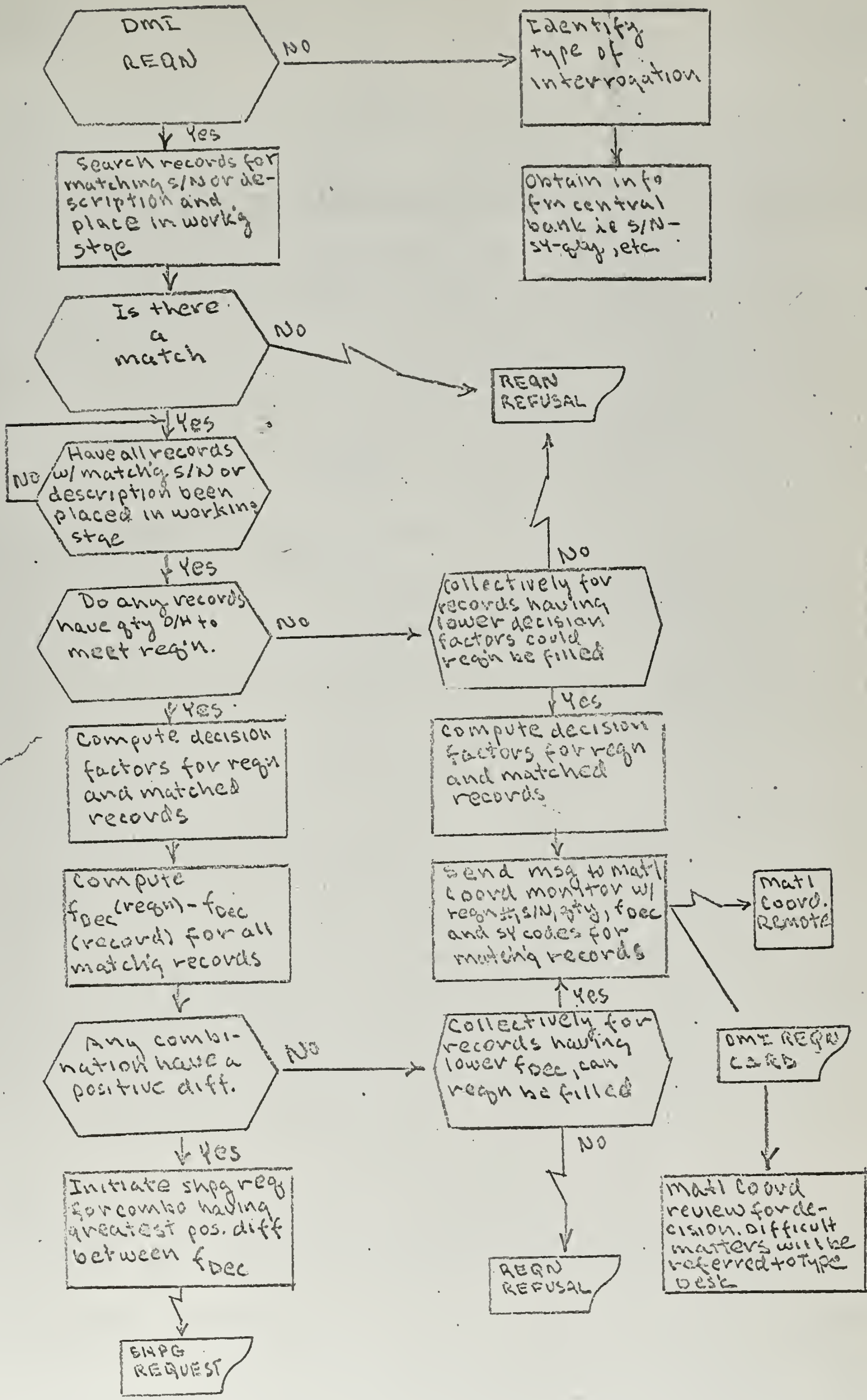
[3]Solid line in upper diagram indicates remote communications link. Dotted lines are liaison links.

[4]May be considered as staff or line organizations responsible for coordinating BuShips material and Shipyard DMI material.



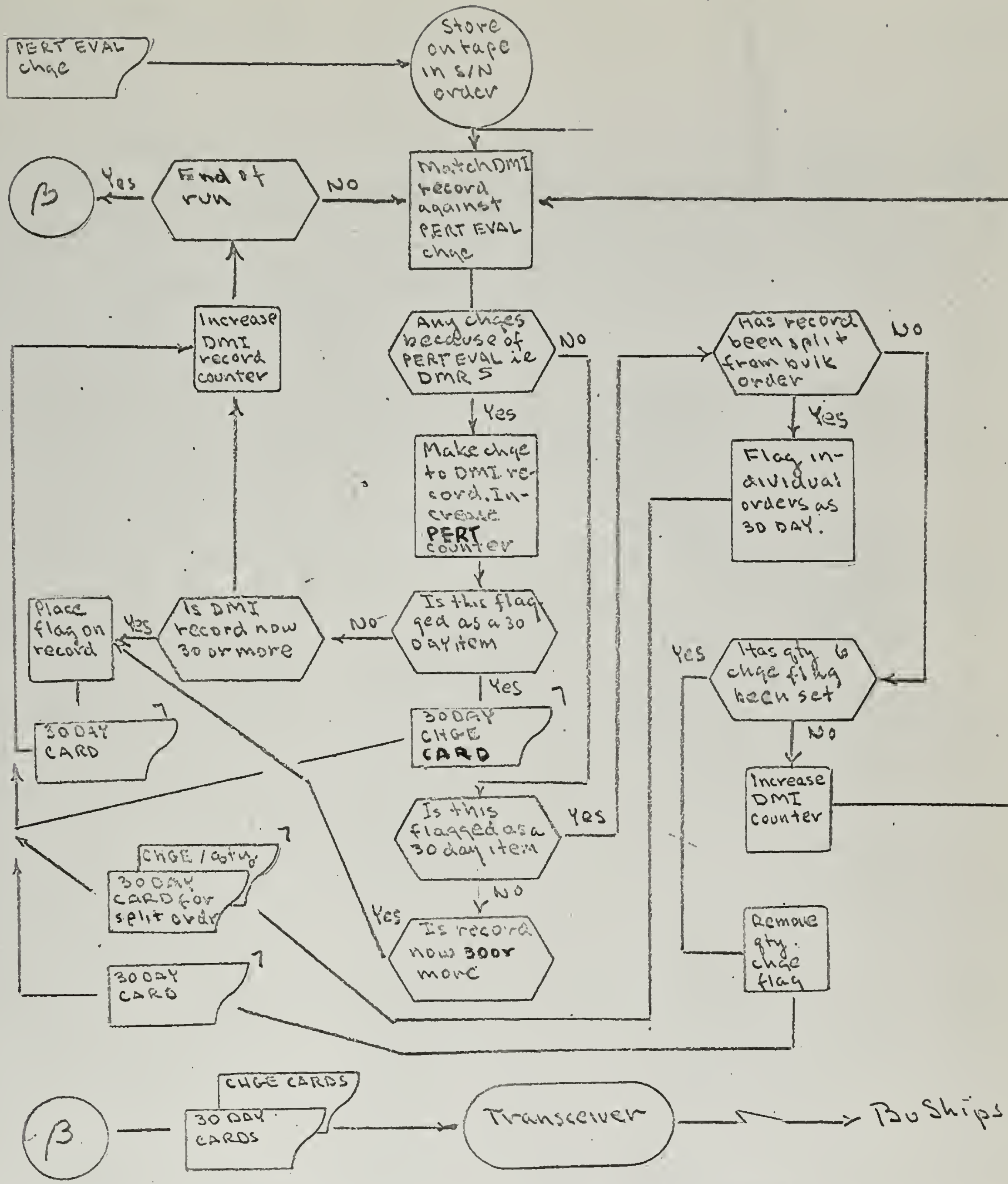
PROPOSED GENERAL PROCESSING PLAN AT BUSHIPS

FIGURE 12



BUSHIPS DMI SCREENING AND REDISTRIBUTION ROUTINE

FIGURE 13



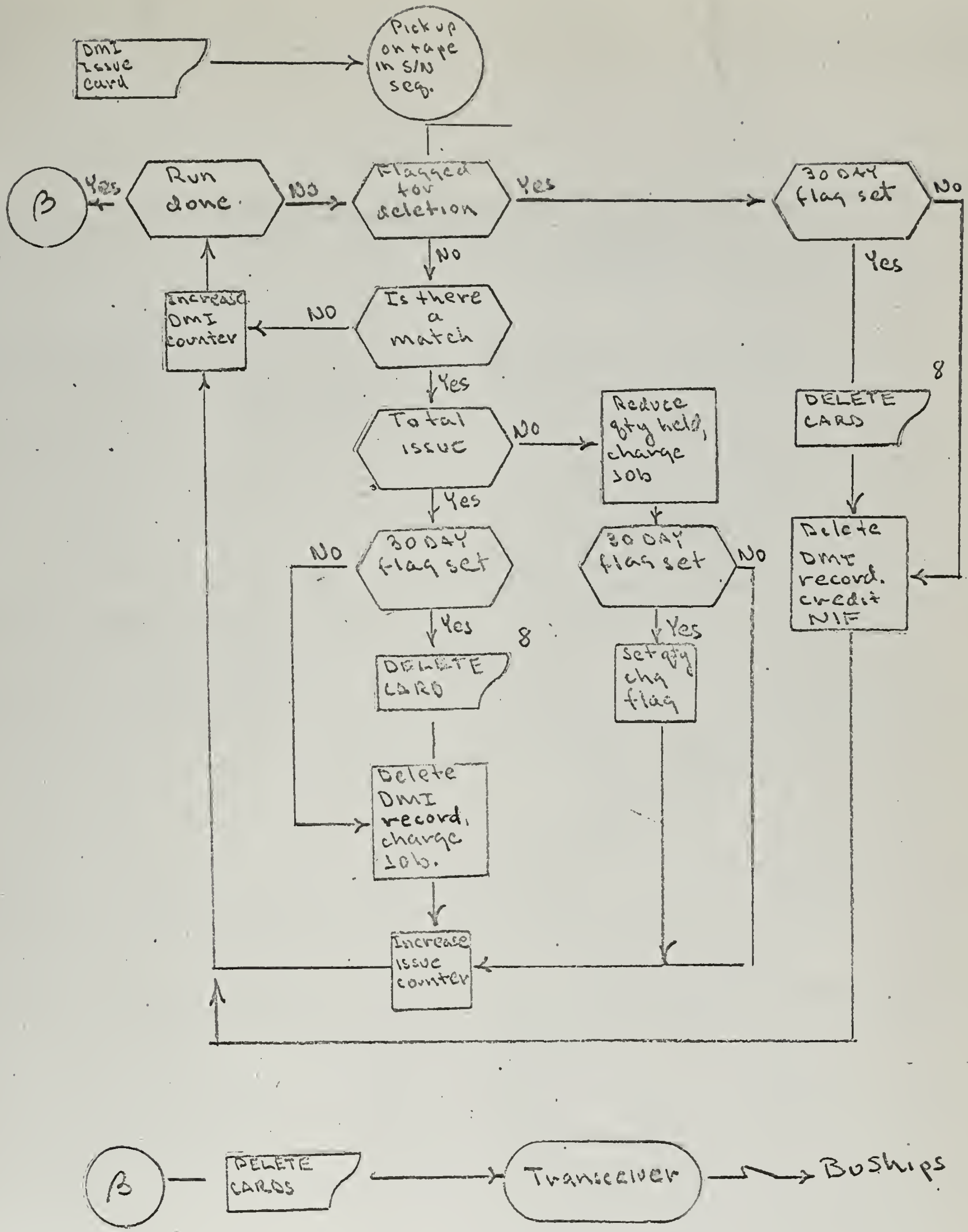
SHIPYARD DMI BIWEEKLY 30 DAY TRANSACTION RUN

FIGURE 14

[5] Deletion items will be identified for pick up on the daily issue run which will generate DMI deletion cards.

[6] Partial issue of 30 day items will have qty flag placed on them as they occur.

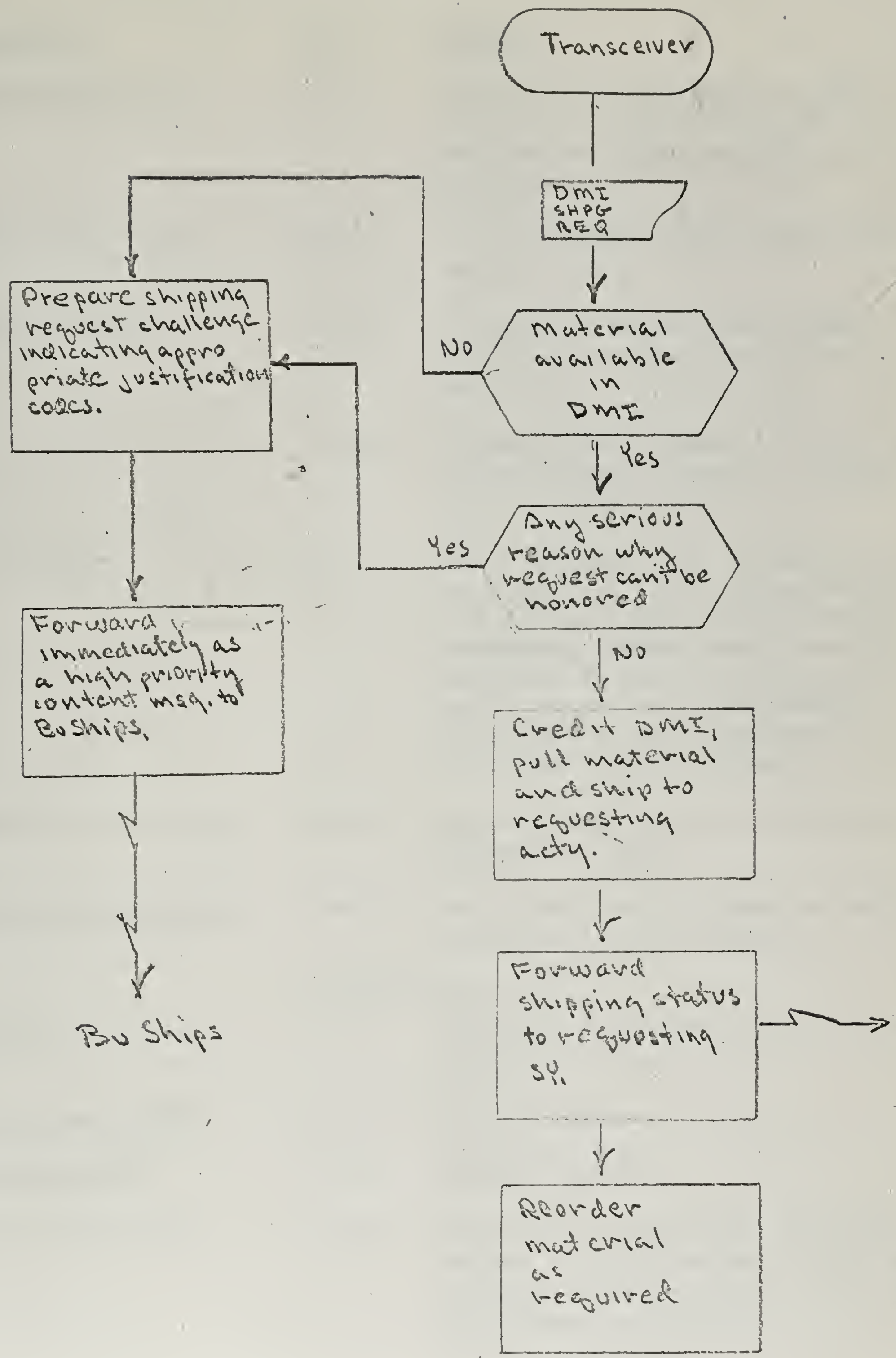
[7] Card is generated and accumulated till run ends. Flow continues as arrows indicate.



SHIPYARD DAILY DMI ISSUE/DELETE CARD RUN

FIGURE 15

[8] Card is generated and accumulated till run ends. Flow continues as arrows indicate.



GENERAL SY PROCEDURE FOR PROCESSING A DMI SHIPPING REQUEST

FIGURE 16

30 DAY DMI CARD/CHANGE CARD

FIELD NAME	CC	PURPOSE
Document Identifier	1-3	Identifies transaction as DMI Std Stk or Nonstd Stk. Stk for pick up or change on BuShip records.
Routing Identifier	4-6	Place BuShips routing identifier here.
Document Number	7-14	Identifies requisition number material is being held under in DMI.
FSN	15-29	Federal Stock Number (If material is nonstandard stock, a trailer card will be used).
Work Category	30	Work category code devised to show type of work, i.e., construction/conversion, repair/modification, emergency CASREP, etc., whether material is being used on a primary, auxiliary or collateral shipboard system, whether job involved is controlling.
Date Material Required	31-34	Shows Julian date material will be used on job.
Ship Accounting Number	35-39	Shows accounting number of ship material is to be used on.
	TRAILER CARD	
Document Identifies	1-3	Identifies card as nonstd trailer card.
Routing Identifier	4-6	Same as above.
Document Number	7-14	Same as above.
Description Coding	15-78	Utilizing a universal SY coding method describe material (std stk quality control material will be considered as nonstd).

CARD FORMATS FOR PROPOSED SYSTEM

TABLE XIV

TABLE XIV (continued)

DELETE CARD[9]

FIELD NAME	CC	PURPOSE
Document Identifier	1-3	Identifies transaction as a standard stk DMI deletion or nonstd stk deletion.
Routing Identifier	4-6	Same as above.
Document number	7-14	Same as above.
Stock Number	15-29	If standard item, only the portion of this field shown will be used.
Description Number	15-78	Nonstd number will be placed in this field.

SHIPPING CHALLENGE CARD

FIELD NAME	CC	PURPOSE
Document Identifier	1-3	Identifies transaction as a shipping challenge.
Routing Identifier	4-6	Routing identifier of challenging yard.
Document Number	7-14	Document number shown on shipping request.
Stock Number of Description Number	15-78	Same as Delete Card.
Challenge Reason	79-80	Through use of alphanumeric codes identify reason for challenge.

DMI REQUISITION CARD[10]

FIELD NAME	CC	PURPOSE
Document Identifier	1-3	Identifies this as a standard or nonstandard stock DMI requirement.
Routing Identifier	4-6	Place BuShips routing identifier here.
Media & Status	7	Code used to indicate method of status desired and to what activity.

[9]With appropriate document identifiers, a format as described for the delete card could be used for interrotation message formats.

[10]Except for fields used after card column 66, this is identical to the prescribed NAVSTRIP requirement card.

TABLE XIV (continued)

FIELD NAME	CC	PURPOSE
Stock Number	8-22	Federal Stock Number.
Unit of Issue	23-24	MILSTRIP unit of issue.
Qty	25-29	Quantity requested.
Service and Document No.	30-43	Requisition number.
Suffix Code	44	For partial requisition and shipment identification.
Supplementary Address		Indicates ship to and/or bill to activity, or used internally by requisitioner.
Signal Code	51	Identifies those elements in the requisition which material should be shipped to and billed to.
Fund Code	52-53	Identifies accounting data.
Distribution	54-56	Identifies cognizance of material and dual addressees for status.
Project	57-59	Identifies formally recognized programs by DOD.
Priority	60-61	Priority of material requirement as determined by mission category and use of material.
Requisition Dely Date	62-64	Date material is required when normal processing within priority time frame will not be satisfactory.
Advice Code	65-66	Codes used to indicate special requisition handling instructions.
Work Category	67	Same as previously described.
Date Material Required	68-71	Date material is to be used on job (Julian).
Ship Accounting No.	72-76	Accounting number of ship material to be used on.

TABLE XIV (continued)

DMI SHIPPING REQUEST CARD

Except for a DMI Shipping Request Document Identifier and use of the Routing Identifier to identify the activity material is being requested from, this card is identical to the DMI REQ'N CARD.

DMI SHIPPING REQUEST TRAILER CARD

Except for a Shipping Request Trailer Document Identifier and use of the Routing Identifier to identify the activity material is being requested from, this card is identical to the DMI REQ'N TRAILER CARD.

DMI REQ'N REFUSAL CARD

Except for a DMI Requisition Refusal Document Identifier, this card is identical to the DMI REQ'N CARD.

The following discussion will treat briefly the objectives of the various systems portrayed. In the case of the Bureau controlled material, "F" and "S" cognizance, little explanation is required in that transactions are presently being forwarded over the AUTODIN network. No change to card formats would be required except possibly in the case of nonstandard equipment, in which case it might be feasible to use a trailer card similar to those shown in Table XIV. The formats for the Bureau controlled material and other logistics programs would be made compatible, if not already, to automatic processing on disk files.

Major considerations towards insuring the effectiveness of this system are the currency and accuracy of its records. This, of course, applies to all files maintained. A prerequisite of this is religious and accurate reporting of transaction data. The greatest transaction volume will be experienced from the DMI portion of the system. Initially it is proposed that only those items on hand in DMI for thirty or more days be reported. As indicated in Figure 14, DMI transactions will be reported biweekly or weekly--weekly being preferred. CHANGE CARDS will be initiated automatically for quantity changes and changes to the date material is required for a job. Date material required changes will be made as a result of periodic PERT evaluations described earlier in this paper. Attention to this detail is necessary in that the decision used by BuShips in redistributing DMI material has the date material is to be used as a major element. The expeditious reporting of issues and deletions is also necessary to the currency and accuracy of the central DMI file. This will be accomplished on the DAILY DMI ISSUE/DELETE CARD RUN shown in Figure 15.

A key part of the BuShips overall program is the DMI SCREENING and REDISTRIBUTION ROUTINE, Figure 13. By comparing a decision factor, which is computed for each matching central bank record against the decision factor computed for the DMI requisition introduced, a decision as to availability of material and source for fulfilling a requirement collectively or individually is made on the basis of the greatest positive difference between decision factors. If no combination can be obtained collectively or individually, a requisition refusal card will be forwarded to the activity requesting the material. Although not indicated in the routine, it might be conceivable that activities having material and quantities on hand could be shown on a trailer card giving the requesting yard an opportunity to negotiate informally with holding yards if appropriate. This matter is not pursued further. In those cases where collectively a requirement may be filled, it is referred to the Material Coordinator over a remote inquiry unit located in the branch area and followed with the requisition card as a tickler for manual review and decision. Particularly difficult decisions will be referred to the appropriate BuShips type desk for a decision. Although it would seem that the decision made at the BuShips is final, a means has been provided for the shipyards to challenge a BuShips DMI SHIPPING REQUEST as shown in Figure 16. However, if just cause cannot be given to justify a challenge, the holding activity will ship the material and forward shipping status to the requesting activity. The shipping activity will also have to reorder replacement material as required. Another feature of the DMI and SCREENING ROUTINE is the provision for interrogating the DMI Central Bank by remote

monitors. Although various combinations of inquiry messages would be available from the central bank, the authors felt it sufficient to acknowledge their potential. Hence, further investigation in this area was not conducted.

In this system, it is proposed that a direct computer/communications interface be developed. This would provide for direct introduction of information to and from the computer at the BuShips. This is proposed so as to reduce manual handling, create the capability for handling large amounts of data, and also provide the capability for rapid handling of urgent requirements. Emergency transations will be handled through use of a priority interrupt feature in the main operating program. Other program routines utilized in the overall scheme except for the DMI SCREENING ROUTINE are rather self explanatory, i.e., DMI MAINTENANCE ROUTINE, "F" & "S" COGNIZANCE MAINTENANCE ROUTINE, etc. However, the DMI MAINTENANCE ROUTINE may prove quite an inefficient operation if record loading of DMI data on the disk files is not well thought out considering the anticipated activity and randomness of additions and deletions.

As can be seen from Figures 11, 12, and 13 the role of the Material Coordinator appears to take on considerable significance in the proposed system. At present there is no organizational group at the BuShips which could function as described in this system. When one looks at the complexity of the BuShips organization with the numerous specialists, it is apparent that there is great need for a single contact point for material supply matters. By supply matters it is meant material problems not necessarily requiring a deep knowledge of the physical material itself. Rather

what is desired are personnel having a good understanding of why and how to get material to the user and where to go to get answers to assist shipyards in resolving their peculiar material problems. It may be that the proposed Material Coordinator Group will be called service specialists. The proposed branch would have functional authority across all lines for coordinating the shipyard material support effort. As shown in Figure 11, the Material Coordinator Group must work quite closely with the Type Desks. Close liaison and cooperation between these groups will be essential to the success of this system. To facilitate decision making and information retrieval, remotes have also been proposed for installation in various locations at the BuShips for use by Type Desks as indicated in Figure 11. Although discussion has been limited to placing DMI material and Bureau logistics programs in random access storage, another area such as SHIPALT status, for example, could also be included. Areas of significance to the Type Desks or other groups in the Bureau for use in random storage are beyond the scope of this thesis.

One of the more immediate obstacles which the authors felt would have to be reckoned with in implementing the proposed system was gaining acceptance of the concept. The authors were rather surprised that in most of the interviews held there were no violent objections or criticism of the concept itself. In most cases, it was observed that the problem of identifying nonstandard material and standardization of quality control measures at all yards would most likely prove to be the system's most serious obstacles in which the authors concur. Since both these areas are worthy of major study, it was assumed for purposes of this study that nonstandard

material could be assigned a number recognizable among the shipyards and the BuShips, and that quality control measures could be standardized for all shipyards. As was indicated earlier, indiscriminate use of this concept could develop serious scheduling problems at the shipyards. This means each shipyard and the BuShips will have to police the use of the DMI concept in much better fashion than has been the case with the present material requisition priority system. In this area, the BuShips will have to provide strong guidance. The information inputs for the various transaction reporting and DMI requisition cards needed by this system are presently available or can be made available as indicated earlier. However, the extent of reprogramming at the shipyard level cannot at the moment be evaluated. It is quite possible these changes may have a chain effect on many other shipyard information processing runs. It is foreseen that a major programming effort at the BuShips will be required. One long range problem which may result at the BuShips level is in the DMI file purging. It may be necessary, in order to avoid creating burdensome reconciliation, to reload the main DMI central locator file periodically from total inventory tapes obtained from each of the shipyards for this purpose.

In order to obtain an idea of the volume of transactions which might be experienced by BuShips in the proposed system, the use of considerable generalization will again have to be resorted to. It is felt that the results should give an idea as to the bounds for expected volumes. In light of the possible need to use trailer cards for nonstandard items, it is likely that volumes will be

nearer the upper bound computed.[11] As can be seen in the following development of processing volumes considerable weight is placed on using average money values for computing line item transactions. The rationale used in developing transaction volumes is discussed in the following paragraphs.

First, it was necessary to determine a ratio of receipts and issues to total line items for Mare Island. This ratio was generalized to all shipyards so as to obtain an idea of the volume of transactions the proposed data bank might experience.

$$\text{No. Line Items} = \frac{\text{DMI Investment}}{\text{Aug. Line Item Money Value}} = \frac{\$7{,}700{,}000^{12}}{\$325.15^{13}}$$

$$= 23{,}700 \text{ Line Items in Mare Island DMI during period of study.}$$

$$\text{Ratio Receipts/Issue to DMI} = (\text{Issue}^{12} + \text{Receipt}^{14})/\text{Total DMI Line Items}$$

$$= (4177 + 4177)/\ 23{,}700$$

$$= .353$$

To develop a figure for what might be the collective transaction reporting by all shipyards, the above ratio was applied to

[11] If it were possible to identify nonstandard material in 41 card columns or less, a trailer card would not be required for the 30 DAY TRANSACTION CARD and CHANGE CARD.

[12] These figures were quoted as part of the results of a six month study conducted by Mare Island in 1964 on an aspect of DMI which was not related to the authors. The DMI investment figure is an average over a six month period in 1964 and the issue figure is an average of line items issued per month from DMI during this same period.

[13] See Table VI for source. The line item money value figure is assumed to be constant also.

[14] A constant DMI inventory is assumed thereby implying receipts equaling issues.

the total on hand figure shown in the Table XII projections as follows.

$$\text{Total DMI Line Item Transaction Reports Per Month} = \text{Ratio}_{\text{Receipt/Issue to DMI}} * \text{Total Line Items On Hand}$$

$$= .353 * 152{,}734$$

$$= 53{,}900 \text{ Line Items/Month}$$

Since there are approximately 22 working days to a month, this figure was converted to a work day average, obtaining approximately 2,450 line items reported per day. Were the authors to use the DMI average line items money value in Tables V and VI, and the total money value of DMI receipts and issues shown in Pearl Harbor's [51] and Mare Island's [50] 'Financial and Operating Statements' to determine line item receipts and issues per day, volumes would be 503 and 564 respectively. These results would imply that receipts and issues are not necessarily related to DMI on hand and the previous assumptions which forwarded this idea might be subject to question. However, due to the fact that information was not immediately available with which to quantify this area otherwise, the authors proposed to use these figures as possible bounds for DMI line items receipt/issue transactions.

The method by which the authors projected the 503 and 564 line item per day for purposes of an upper bound was based on the assumption that regardless of DMI investment, DMI receipt/issue transactions may be fairly consistent between repair and between construction shipyards. Since there were six shipyards designated in this paper as construction oriented, Mare Island's figure of 564 line items per day would result in a total of 3,384 line items per day reported. Using the same analogy for repair

shipyards and Pearl Harbor's figure of 503 line items per day, a total for all five repair shipyards would result in 2,515 line items per day reported. It is recognized that this may be stretching matters considerably; however, it is the contention of the authors that the figures shown below are adequate for purposes of getting an idea as to the possible equipment needs of the proposed system. Also shown are figures reflecting 70% of the quantities developed. The reason for showing these statistics is the fact that from the authors experience, approximately 30% of the line items ordered into DMI are likely to be used within 30 days. As a result, the 70% figures may be of more interest in that it will be proposed that the DMI information be restricted to requisitions over 30 days old.

	TOTAL	70%
UPPER BOUND	5899	4130
LOWER BOUND	2450	1715

DMI RECEIPT/ISSUE TRANSACTIONS
PER DAY OF 22 WORKDAY MONTH

TABLE XV

Information regarding activity of "F" and "S" cognizance material is just as sparse.[15] As a result, projections for daily transactions such as issues, receipts, redistributions, and disposal were developed in two manners. One based on the authors experience, and the other based on converting the financial data obtained on receipts and expenditures to line items utilizing an

[15] BuShips is the inventory manager for "F" and "S" cognizance material. This material is primarily major equipment which taken individually or collectively represent a considerable investment. The only data available for projection purposes were financial abstracts [48].

[illegible]

average line item value developed for "F" and "S" cognizance material.[16]

The subjective opinion of the authors regarding activity of "F" and "S" cognizance materials was that "F" cognizance material had an annual turnover of 70% and experienced about 10,000 transactions per month. Based on a 22 workday month, this obtains a figure of 455 line items per day activity. "S" cognizance was felt to have a 20% annual turnover and experienced approximately 2,000 transactions per month. Based on a 22 workday month, this obtained a figure of 91 transactions per day. Utilizing financial data from a BuShips Financial Inventory Abstract [48], "F" cognizance receipts totalled 203 million dollars for receipts and 217 million dollars for expenditures for a three month period. Figures for "S" cognizance material from the same source were 233 million dollars receipts and 239 million dollars in expenditures over the same three month period. These figures were broken down into line item transactions per 22 workday month using average line item values of $65,600 and $32,800 for "F" and "S" cognizance materials respectively. Results of line item activity have been incorporated in the general line items transaction per day summary shown in Table XVI.

[16] Specifically, the "S" cognizance inventory amounts to 9,585 line items with a total investment of 328 million dollars and an average line item value of $32,800 [48]. "F" cognizance material amounts to 5,535 line items with a total investment of 363 million dollars and an average line item value of $65,600 [48].

	70% LOWER BOUND	LOWER BOUND	70% UPPER BOUND	UPPER BOUND
DMI TRANS	1715	2450	4130	5899
F COG	145	145	455	455
S COG	326	326	91	91
TOTAL	2186	2921	4676	6445

SYSTEM TOTAL LINE ITEM TRANSACTIONS REPORTABLE TO BUSHIPS PER DAY OR 22 WORKDAY MONTH

TABLE XVI[17]

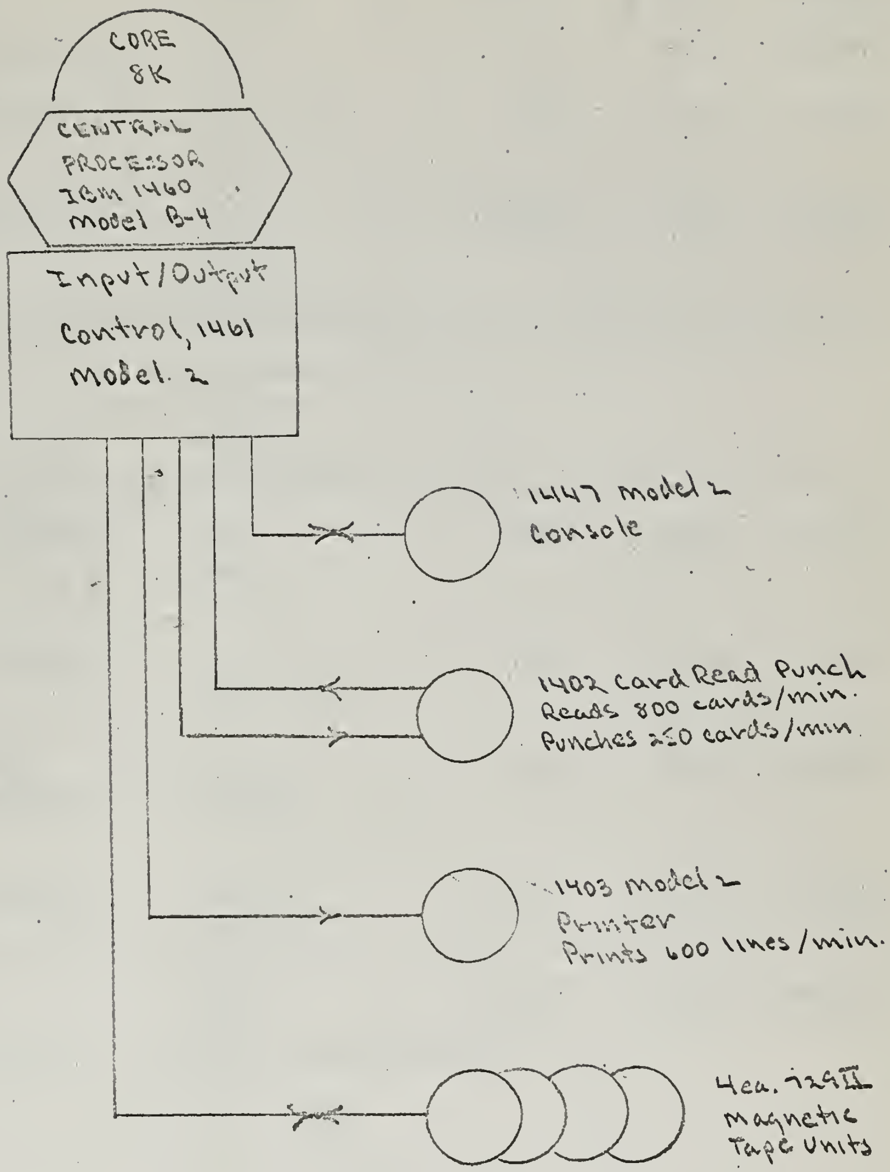
If one were to consider the ratio of standard stock, 31%, and nonstandard stock, 69%, items on hand to total line items on hand as developed from data in Table XII another possibility exists as to the upper and lower bounds shown in Table XVI in that nonstandard DMI item transaction reports under the proposed system may require a trailer card. This would increase the upper and lower bounds to 10,905 line items per day and 3,696 line items per day respectively. Due to the possible large volumes indicated, it seems that a direct link between computer and communications network would be most desirable.

Although some information is available regarding BuShips computer system configuration, it is restricted primarily to central processors and storage media used as follows: (1) one IBM 7074 central processor with ten K memory and ten tape drives, (2) two IBM 1460 central processors with eight K memory and four tape drives each.[18] A likely representation incorporating the

[17]The 70% amounts only refer to DMI transactions. No change was made to other figures. DMI figures were obtained from Table XII.

[18]Information is based on personal correspondence between one of the authors and BuShips.

above equipment into a proposed system appears in the Figures and Tables that follow.



ASSUMED CURRENT BUSHIPS IBM 1460 SYSTEM CONFIGURATION[19]

FIGURE 17

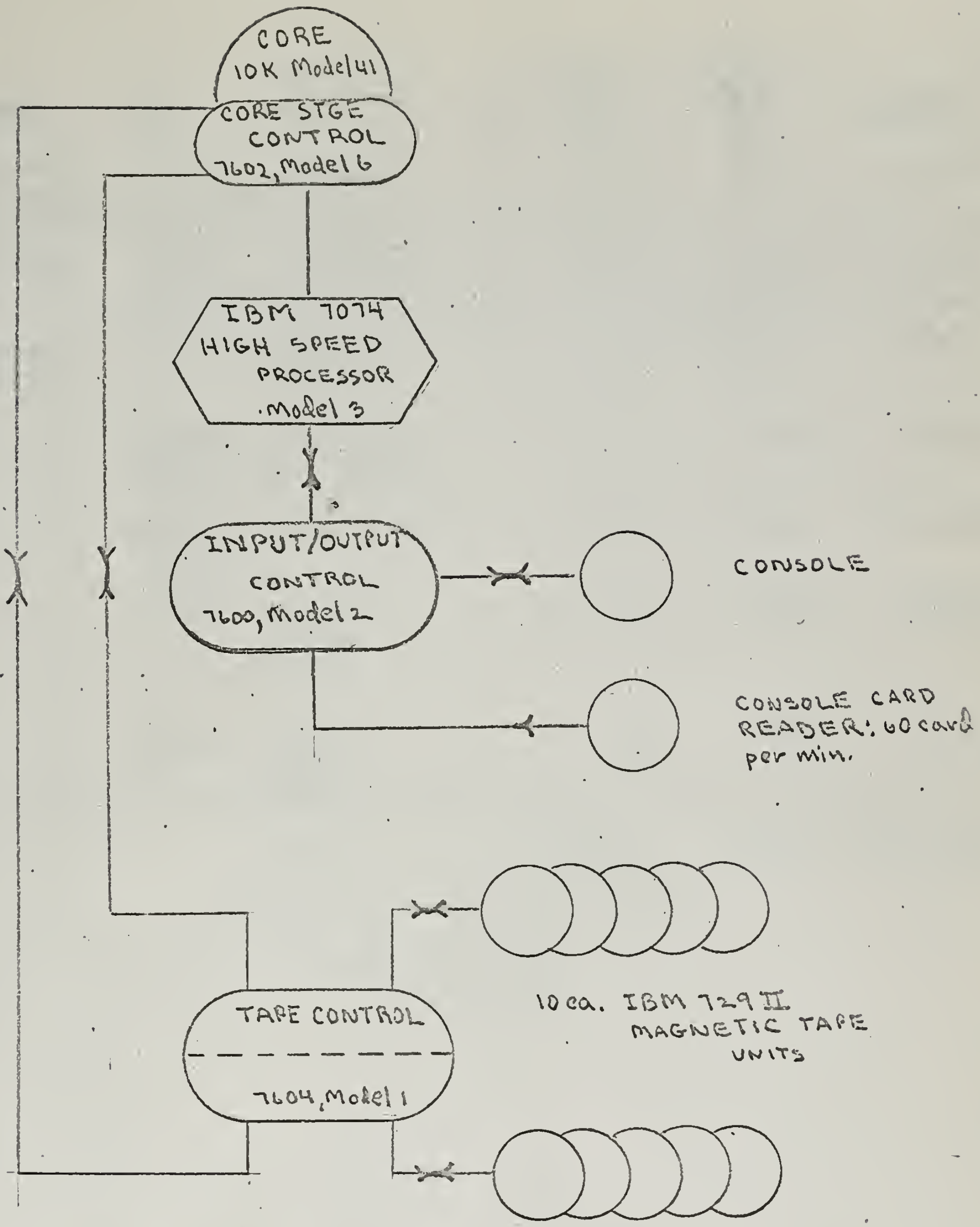
[19] This system is, except for the number of tape units, an exact duplication of what the Auerbach Corporation represents as a 6 TAPE BUSINESS SYSTEM: CONFIGURATION [25]. BuShips has two complete systems.

CLASS	NO.	IDENTITY OF UNIT	QTY	$ MONTHLY RENTAL	$ MONTHLY MAINT.	$ PURCHASE
Central Processor	1441,Mod.B4	Core, 8K	1	2,130.	42.25	108,800.
	1447,Mod.2	Console w/ Printer	1	290.	17.75	14,200.
	1461,Mod.2	I/O Control, Card/729 Tape System	1	1,980.	33.50	90,200.
Internal Stage		Included in 1441 Processing Unit Above	1			
Input/Output	1402,Mod.3	Card Read Punch	1	560.	45.00	30,215.
	1403,Mod.2	Printer (600, lpm)	1	775.	140.00	34,000.
	5585 (Optional)	Print Storage (On 1461)	1	375.	26.00	12,600.
	729,Mod.II	Magnetic Tape Unit	4	2,800.	464.00	144,000.
		Totals		8,910.	768.50	434,015.

COST DATA ON ASSUMED 1460 SYSTEM[20]

TABLE XVII [25]

[20] It is noted that BuShips has two IBM 1460 systems.



ASSUMED CURRENT BUSHIPS IBM 7074 SYSTEM CONFIGURATION[21]

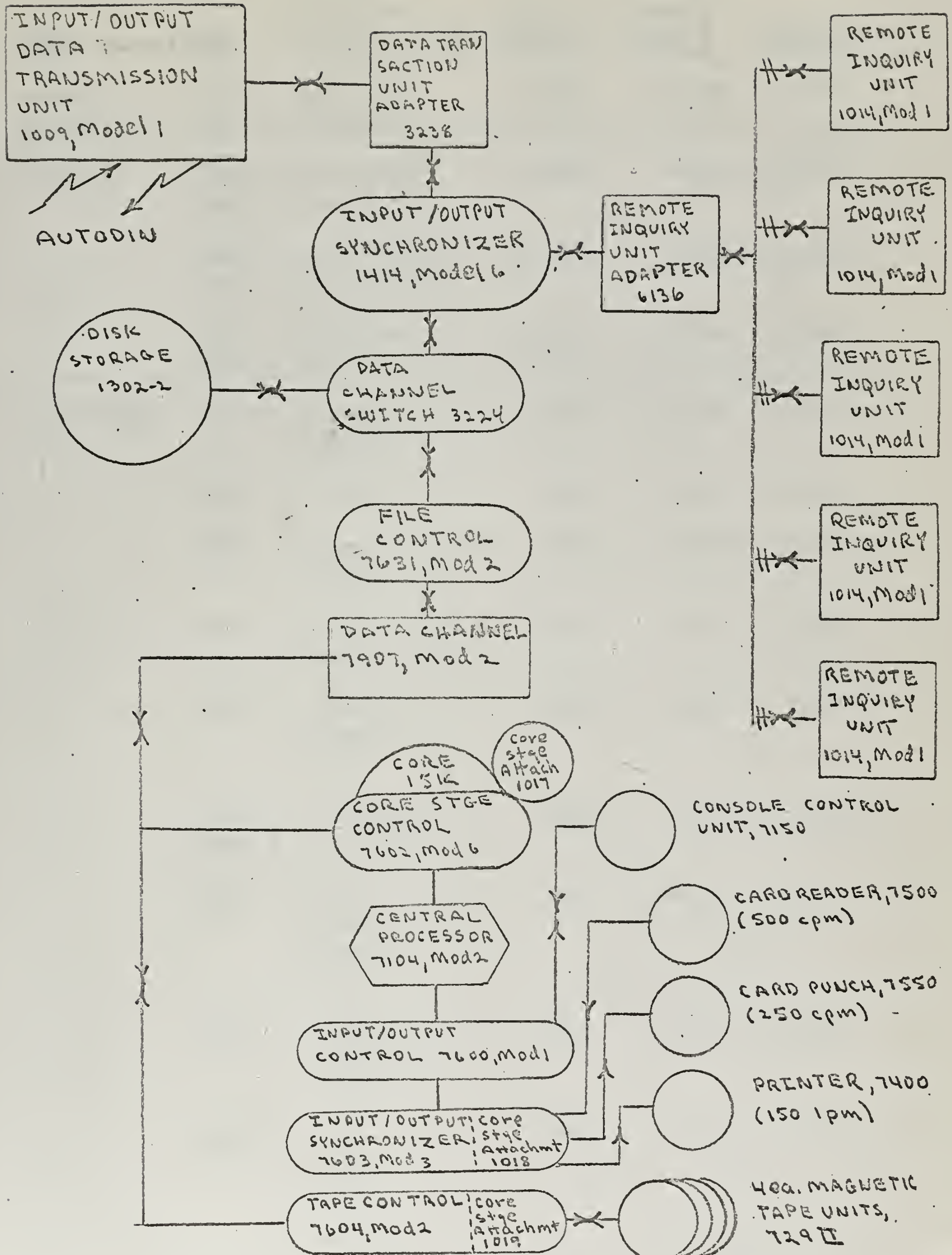
FIGURE 18

[21]Except for the size of core and number of tape units this configuration is identical to Auerback Corporation's 10-TAPE GENERAL SYSTEM CONFIGURATION (PAIRED) [25].

CLASS	NO.	IDENTITY OF UNIT	QTY	$ MONTHLY RENTAL	$ MONTHLY MAINT	PURCHASE
Central Processor	7104, Mod. 3	Two Tape Channels	1	7,300.	215.00	313,000.
Storage	7301, Mod.41	Core Stge 10K Words	1	8,000.	55.00	373,000.
Input/ Output	729 II	Magnetic Tape Unit	10	7,000.	1,160.00	360,000.
	7600, Mod. 1	Input Out-put Control	1	1,400.	41.00	63,000.
	7604, Mod. 1	Tape Control	1	2,700.	86.75	125,500.
	7150	Console Control Unit	1	300.	15.50	13,050.
	7501	Console Card Reader	1	100.	6.25	4,300.
		Totals		26,800.	1,579.50	1,251,850.

COST DATA ON ASSUMED 7074 SYSTEM

TABLE XVIII [25]



PROPOSED IBM 7074 COMPUTER CONFIGURATION[22]

FIGURE 19

[22]This system would include an off line system as described in Fig. 17. In this case only one of the 1460 systems would be used.

CLASS	NO.	IDENTITY OF UNIT	QTY	$ MONTHLY RENTAL	$ MONTHLY MAINT.	PURCHASE
Central Processor	7104, Mod. 2	One Tape Channel	1	7,400.	217.00	317,000.
Storage	7301, Mod. 3	Core Stge. Module 5k	1	4,700.	48.75	225,000.
	7301, Mod. 41	Core Stge. Molule 10k	1	8,000.	55.00	373,000.
	1302, Mod. 2	Disk Storage	1	7,900.	310.00	355,000.
Input/Output	729 II	Magnetic Tape Units	4	2,800.	464.00	144,000.
	7400	Printer	1	950.	40.50	37,000.
	7500	Card Reader	1	400.	44.75	13,100.
	7550	Card Punch	1	550.	36.75	19,500.
	7150	Console Control Unit	1	300.	15.50	13,050.
	1414, Mod. 6	I/O Synchronizer	1	850.	12.00	43,350.
	1009	Data Transmission Unit	1	500.	42.50	22,400.
	1014	Remote Inquiry Unit	5	1,000.	62.50	55,000.
	3238	Data Transmission Unit Adapter	1	200.	3.50	11,000.
	6136	Remote Inquiry Unit Adapter	1	200.	5.75	11,500.

COST DATA ON PROPOSED SYSTEM

TABLE XIX [25]

TABLE XIX (continued)

CLASS	NO.	IDENTITY OF UNIT	QTY	$ MONTHLY RENTAL	$ MONTHLY MAINT.	PURCHASE
Controllers	7602, Mod. 6	Core Storage Control	1	1,200.	25.00	49,400.
	1017	Additional Core Attachment for Processor	1	400.	8.25	16,350.
	1018	Additional Core Storage Attachment for I/O Synchronizer	1	50.	1.00	2,100.
	1019	Additional Stge Attachments for Tape Control	1	50.	4.00	1,800.
	7600, Mod. 1	Input/Output Control for any Card Systems	1	1,400.	41.00	63,000.
	7603, Mod. 3	Input/Output Synchronizer (Unit Record), One Input, Two Outputs	1	1,350.	31.25	48,300.
	7907, Mod. 1	Data Channel (for 1414, 1302 DSU) One Channel	1	2,000.	61.00	80,000.
	3224	Data Channel Switch	1	25.	1.25	650.
	7604	Tape Control (729's)	1	2,700.	86.75	125,500.
		Totals		44,925.	1,618.00	2,027,000.

As can be seen, the monthly rental, $44,925, of the new IBM 7074 system shown in Table XIX is nearly double that of what the authors have assumed as the current IBM 7074 system, $26,800, shown in Table XVIII. However, a sizeable amount of equipment in the currently assumed system, approximately $22,500, could be used in the proposed system. Also consider the fact that the proposed system utilized only one IBM 1460 configuration which would reduce rental by approximately $8,910. In our hypothetical situation, the current system rental per month amounts to $44,620 and the proposed system rental would amount to $53,835 obtaining an increase of $12,815 rental per month.

The creditability of the above comparisons loses a certain amount of effect for two reasons. First, the current systems portrayed can only be spoken of in a hypothetical manner, that is, they represent systems which the authors have inferred on the basis of information obtained only to the extent of what central processors and storage media were currently being used in BuShips. The assumptions made are partially justified, however, in that the basic equipment as related to the authors fit quite closely to standard computer configurations except as was expanded by the authors.[23] The other reason which detracts from the weight one might place on the comparison between the current and proposed systems is that no specific figures were available to justify deleting one of the IBM 1460 system. To wit, it is highly likely that these IBM 1460 systems are used off line for report and

[23]These systems were very closely identical to the 6 TAPE BUSINESS, CONFIGURATION III for the 1460 and the 10-TAPE GENERAL SYSTEM CONFIGURATION (PAIRED) as shown in the Auerbach Corporation Standard EDP Reports [25].

information preparation throughout the BuShips. It is the authors' contention that through the use of remote inquiry units and random access storage plus the additional feature of input and output available directly from the main frame, adequate processing capability should be possible.

Not mentioned, heretofore, is the information related to the authors in private correspondence regarding present intentions by BuShips to replace the IBM 1460 systems with the IBM 360 Model 30 configuration systems. The implication, should this be approved, seems to the authors will most likely result in a dual configuration similar to that shown in Figure 17 except for a different generation of equipment, and a considerable increase in processing ability off line. This, however, has further significance. The IBM 360 generation computer is the newest IBM system on the market. Its impact on future systems design will be felt for many years to come; for what the authors feel, its versatility as regards to its modularity and compatibility with a wide range of input/output devices. The significance of the proposed system using the IBM 360 rather than the IBM 7074 is the greater versatility the IBM 360 system would have for the same cost or less. The major drawback as far as the authors are concerned would be the possible extensive reprogramming which might be required to change to a totally integrated IBM 360 configuration. Since considerable reprogramming would be necessary under the proposed system, the drawback of the IBM 360 system loses weight. Nevertheless, the general idea represented by the IBM 7074 system would be the same, namely, random access storage for material and other files used daily, with remote inquiry units strategically located for immediate access of needed

information. Also included is a direct interface, IBM 1009 Data Transmission Unit, between the computer and incoming and outgoing data for timely processing of requests and transactions, and reduction in manual processing.

Having obtained an idea as to the possible costs of the systems involved, it might be well to look at some of the specific equipment involved, problems anticipated in data storage and retrieval, additional features, and possible modifications. One noticeable aspect of the proposed system is its general similarity with the UADPS system configuration for small and medium size inventory stock points.[24] The primary differences between the UADPS system and the proposed system is the central processors of the on line and off line configuration used, and the direct interface between the core of the main processor of the proposed system and communication facilities.

The proposed system indicates a need for a 15K core memory thereby increasing the present core 5K and represents a $4,700 per month rental increase. The increased core memory as stated to the authors by the IBM representative at NSC Oakland would adequately handle the system being proposed. However, it was also felt that the system with proper programming and use of a disk overlay concept could operate with 10K core storage. Also discussed with the NSC Oakland IBM representative was the disk storage capacity needed for the proposed system. The representative

[24] UADPS stands for Uniform Automatic Data Processing System. A study by BuSanda [59] regarding implementation of this system in 1962 showed volumes for small activities closely approximated projected figures for the system proposed for BuShips in this paper in the area of issues, receipts and total inventory. Due to lack of figures from BuShips for internal activity needs, a complete comparison could not be made.

made a rough guess based on the information given him that an IBM 1302-2 model disk storage device would be more than adequate in light of the special programs and volume of transactions involved.

Further investigation reveals several possible alternatives with regards to the disk storage devices used. The rationale for determining track capacity for recording data in the six bit mode is total characters per track minus characters required for the home address, minus the product of the number of records to be used in a track and characters required for the record address and record gap [28]. The following results are obtained for the various disk storage devices using fixed length records of 80 characters which are blocked end to end using only one record address per track (1) IBM 1301-Mod-1, 170,000 records, (2) IBM 1301-mod-2, 340,000 records, (3) IBM 1302-mod-1, 730,000 records, (4) IBM 1302-mod-2, 1,460,000 records.[25] If data were recorded in the eight bit mode, storage capacity would be reduced by approximately 22%. Since the method of blocking proposed implies sequential loading of data, it represents a "brute force" approach towards packing and maintaining files. Processing problems would result in such a method if record addition and deletion were high due to the need for constant rearrangement of records to keep tracks on the disks full. A modification of this approach would be to leave some tracks empty to reduce the time lost in record rearrangement. Another approach is to use the random file approach

[25] It is noted that nonstandard records under the proposed method may require up to 160 characters which would have to be considered.

where each record is given a record address. Although this would reduce access time, it also reduces disk storage space utilization up to 15% [30]. In essence, this area will pose one of the more difficult problems in developing the proposed system, namely, the optimum arrangement of records in random storage. Once the operating programs and special program sizes and transaction volumes are determined, a smaller disk storage unit than that proposed may prove more economical. This does not rule out the possibility that additional storage units may be required as a result of additional applications.

The central processor to be used in the proposed system is the same one presently being used. Three basic types of processing routines are visualized as being the key to the system. They are (1) a general monitor program controlling the types of transaction involved and calling the appropriate routine and priority interrupt feature as necessary, (2) a screening and redistribution routine for both types of material, and (3) a maintenance routine for both types of material. In the case of "F" and "S" cognizance material, a requisition control status routine will also be required. Indicated in the literature for this machine is a priority interrupt feature which provides for automatic execution of a priority routine whenever an operation is completed by a peripheral unit or a manual inquiry is made. [25] This feature is considered an absolute necessity to the system.

The communication/computer interface used is an IBM 1009, Model 1, Data Transmission Unit. This enables the IBM 7074 system to transmit and receive data over telephone, or telegraph lines at speeds of 75, 150, 250, and 300 characters per second.

The unit at the other end of the line can be a similarly equipped IBM 7000 series or IBM 1400 series system, an IBM 7701 or IBM 7702 magnetic tape transmitting terminal, or an IBM 1013 card transmission terminal [25]. One significant problem, it is felt, will develop under this system if volumes come in large batches, namely, queues of incoming data. A weakness of the IBM 1009 data transmission unit is that it has no means for segregating priority transactions out, or back up features for accumulating overflows. An alternative to this equipment is the IBM 1976 Data Communications Terminal which was especially designed for use with the AUTODIN system. This equipment offers considerably more versatility and power. It can be equipped with an alternate back up tape, can receive and transmit at the same time, and transmit and receive on one side in emergency situations resulting from failure of either side of the transmission facility [31]. The major drawback of the use of this system in the proposed configuration is its cost of $2,480 per month versus $500 per month for the 1009 terminal [25].

The use of five IBM 1014 remote inquiry stations in no way restricts the number to this amount. The additional flexibility and usefulness of this equipment may justify more. In essence it consists of a modified typewriter with control circuits and indicator lights mounted on a 29 x 24 inch table. It interrogates and prints replies from the central processor at distances up to eight miles. Message lengths are limited to 78 characters and up to ten inquiry units can be connected to an IBM 6136 remote inquiry adapter which in turn is connected to a 1414 synchronizer [25]. As can be seen, the proposed system provides for five units

although it could accommodate five more. The rental price of these units is extremely reasonable, $200 per month, considering the many advantages gained by use of this equipment.

Up to this point discussion concerning cost of the proposed system has centered on rental costs. In deciding on any system such as this, due regard should also be given to advantages which might be gained in purchase of equipment. Key factors which must be evaluated before deciding this issue would most certainly center on plans for future expansion and trends in computer design which may prove to be more advantageous over present equipment. In the UADPS study the decision was made to purchase some of the more major equipment, i.e., central processing units, since changes to this, the heart of the system, would require costly reprogramming expenses. Equipment, i.e., storage devices, and input/output devices, susceptible to improvements which would not affect the need for drastic system reprogramming were leased [39]. In essence these same conclusions are recommended by the authors.

SUMMARY

The increasing awareness of managers to the value of information and improvements made in computer hardware has created significant interest in management information systems. As a result, SecNav recognizing this trend in 1959 and the need for greater utilization of computers in Navy logistics and business administration outlined a general plan to accomplish this purpose [33]. BuSanda's interpretation was the Uniform Automatic Data Processing System which has recently been implemented. BuShips is in the process of implementing its own program called the BuShips MIS for U. S. Naval Shipyards. Whereas the BuSanda UADPS stressed mass random access storage and central control, the BuShips MIS program emphasis was in standardization of reports in the production planning and control, and cost accounting areas. The decision to use random access storage was left pending further trends. It was also recognized by BuShips that more central guidance on their part in the area of management information systems and use of automatic data processing concepts would be needed.

As a further extension of the BuShips MIS program, the authors proposed the creation of a central data bank for shipyard DMI material, Bureau controlled stocks, and logistics information. It was proposed that this information be located in random access storage at the BuShips. The object of this concept is to provide a completely automated system capable of providing rapid processing of file maintenance transactions, requisitions, and status requests. Through the use of remotes, additional power was given the system by providing a means for current and accurate information

retrieval for decision making within the BuShips. One notable difference in this material system from those conventionally thought of is the proposed utilization of shipyard DMI material for urgent requirements for which the regular methods of procurement have or will fail to obtain timely delivery of material. Since DMI is not recognized in the formal supply system, in that it is for all intents and purposes an end use requirement, great care will be needed in controlling the use of this concept. To include the shipyard DMI utilization concept formally into the proposed integrated system, inventory status of selected items or categories of DMI will be maintained in the proposed central data bank for screening and redistribution action as portrayed in Figures 10, 12, 13, and 16. To keep this file current, transaction reporting will be accomplished as depicted in Figures 10, 12, 14, and 15. The key to the effective use of this system is the creation of what the authors refer to as a decision factor. This rule is visualized as a consistent unbiased arbiter of the urgency of one requirement over another making it adaptable for use in an automated process as shown in Figure 13. Recognizing that some leeway must be given for subjective judgement, provision has been made for shipyards to challenge a BuShips DMI shipping request as is shown in Figures 12 and 16. As is shown in Figures 11, 12, and 13 a Material Coordinator Group assumes a significant role in this system. The authors feel that a group such as depicted is necessary to provide one single point that shipyards can contact to resolve their material problems which are peculiar to this system. The various implications of establishing this group have not been investigated.

An attempt was made to obtain an idea as to the possible bounds on data volume which might be experienced by the BuShips under the proposed system. Through the use of extensive generalization from figures obtained from a DMI study made by Mare Island in 1964 and BuShips controlled material financial reports, approximate bounds were generated as shown in Table XVI, the range being 2,186 to 6,445 line items per day. Further consideration was given additional volume which might be created by the use of trailer cards for nonstandard material obtaining an adjusted approximate range of 3,696 to 10,905 line items per day.

Based on information received in personal correspondence from the BuShips regarding computer equipment presently in use, computer configurations were developed which conformed to a great degree with standard configurations reviewed. At present BuShips has two IBM 1460's with 8K core memory and four tape drives each, and one IBM 7074 with 10K core memory and ten tape drives. These were assumed to approximate for the most part what the Auerbach Corporation Standard EDP Reports [25] represent for the IBM 1460 central processor as a "6 Tape Business System: Configuration III," and for the IBM 7074 central processor as a "10-Tape General System Configuration (paired)."[26] It was assumed that from various standard configurations reviewed, the IBM 1460 systems represent off line systems for work not requiring the power of the IBM 7074 system. Cost data on these systems is shown in Tables XVII and XVIII.[27]

[26]Since ten tape drives can be connected to one channel it cannot be absolutely determined that the IBM 7074 configuration is one or two channels. See Figure 18.

[27]The combined IBM 1460 configuration package was costed at $17,820 per month rental and the IBM 7074 configuration was costed at $26,800 per month rental.

[illegible]

There are several significant differences between the present configurations and the proposed configuration. These differences are as follows: (1) use of only one IBM 1460 configuration as presently developed, (2) introduction of random access storage in place of six tape drives, (3) use of a direct interface between computer and communication network, (4) use of remote inquiry devices, (5) the possible increase of core to 15K, and (6) input/output capability from the main frame. It is felt by the authors that even with the scanty knowledge they have on input/output volumes, the proposed system should be capable of handling the areas proposed in this paper for the central data bank. This statement is made with the added knowledge that input/output volumes generated in this paper are similar to that of a small or medium inventory stock point, after which this configuration is patterned [59]. Cost data is shown in Table XIX for the proposed IBM 7074 configuration.[28]

Comparison of the current system monthly rental costs, $44,620, and the proposed monthly rental costs, $53,835, reveal a net increase of rental costs of $12,815 would be required to implement this system. Mention was made of the possibility of BuShips replacing the IBM 1460 and IBM 7074 configurations with an IBM 360 configuration. Since the IBM 360 system is a more flexible one, some consideration should be given to a fully integrated IBM 360 system. It is understood that transition to the IBM 360 system requires extensive reprogramming, which is one of the drawbacks of the system. Since extensive programming would be required to implement the proposed system, serious thought

[28] Monthly rental was costed at $44,925.

should be given to the IBM 360 system due to its modularity and compatibility with a wide range of input/out devices. Nevertheless, whatever manufacturer type is decided upon the general idea of the proposed configuration should be the same. Consideration, if this proposal were to be implemented, should be given also to the advantages of purchase over leasing. Under the BuSanda UADPS program this was for the most part limited to the central processor. Storage devices and input/output devices were leased since the equipment change in these areas would not require extensive reprogramming [59].

The affect of this system on program runs at the individual shipyards cannot be foretold. However, it is felt that some difficulty may be experienced in finding room on current requisition/accounting card packages at the shipyard level which may also affect their current report formats. Loading of DMI data on the disk files may prove a problem due to the volume and nature of the material involved. Since this system requires use of card formats which for the most part are not compatible with NAVSTRIP, there is the possibility that some objections from BuSanda or the Defense Supply Agency may be received. However, because it is a restricted system, the use of card formats as described may be allowed.

Despite many of the problems and costs which may be encountered in this system, how can one properly evaluate the advantage it might provide in a situation created by the cold war in getting a ship completed on time? By closer cooperation and mutual action by all shipyards as a whole, how can one evaluate the advantage gained over current commercial shipbuilding enterprises? The

authors have no answer to these questions, but feel they are of such significance that due regard be given them when considering the merits of this proposed system.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

Recent progress in the utilization of automatic data processing systems as well as technological advances made in ship design and shipboard equipment have served to emphasize the need for reappraisal of current logistics support patterns among shipyards. No longer is it practicable to consider only traditional material support concepts as the sole alternative for increasing material effectiveness. In order to meet the challenge of cold war emergencies and competition from the private sector, the Navy must find a way to harness the potential that naval shipyards have collectively. The relative autonomy that each shipyard has enjoyed in the past cannot help but create a parochial view on the part of each shipyard which must be overcome. The answer to this is standardization and stronger central guidance from the BuShips. Fortunately, the BuShips is recognizing this to a degree which is manifest in its MIS program. Although a step in the right direction, the MIS's main contribution as visualized by the authors is standardization of reporting methods. This is a prime prerequisite of any management information system. The extension of the MIS to the use of scientific management methods such as the PERT evaluation is still on the horizon. The realization of the potential uses of DMI in an integrated system is nonexistent.

Although the results of this study show a remarkable similarity between the distribution of standard stock material on hand at Mare Island and Pearl Harbor, except for those areas noted as peculiar to each shipyard's mission, a direct statement cannot be made that individual items are similar. It, however, implies that

some of the material may be eligible for mutual utilization. Lacking comparable data for nonstandard material only conjecture can be offered that a similar relationship exists. Experience has shown that material problems are not unique to one shipyard or to any particular period of time. Inasmuch as analysis of comparable data was limited, it can only be speculated from data reviewed, interviews, and experience, that benefit could be obtained from mutual use of on hand DMI. It is further felt that repair shipyards which must work under considerably shorter lead times than construction yards would benefit more from the system. As to the question of whether material is in DMI long enough to make it worthwhile to put this information on a central data bank, more conclusive results were obtained. Material was found to be on hand at Pearl Harbor for approximately 152 days on the average, whereas Mare Island, being a construction shipyard was found to have material on hand approximately 681 days. Projections made to determine the quantity of DMI information which might be contained in the proposed data bank obtained a figure of approximately 152,000 line items. This figure could be pared down considerably by intelligent screening. Transaction reporting volume into the Bureau to maintain the desired system within the possible range of 2,186 to 10,905 transactions per day is so inconclusive that further study of this would have to be made. However, it was felt by the authors that within these ranges a direct communications/computer interface at the BuShips would be desirable in the proposed scheme.

Most of the information needed for the proposed system is currently available or could be made available under the MIS program. However, there still remains the need for a means of quantifying a

consistent priority decision rule and identification of non-standard material in some recognizable manner. Unfortunately these two elements are essential to the proposed system, for the system as set forth would not be workable without them.

The concept and computer configuration forwarded in this thesis is in many respects similar to that installed at small and medium inventory stock points which operate under approximately the same input/output volumes [59]. It cannot, however, be implied that this system will be as feasible because of the nature of material involved, difference in activity missions and restricted use of DMI. Comparisons between present and proposed computer configurations is the only area in which a general approximation can be obtained relative to cost. Such areas as reprogramming at the Bureau and shipyard level, and quantification of benefit obtained cannot be developed. As a result, it is felt that the main contribution this thesis can provide is to point out current weaknesses in the area of shipyard material management, and provide a motive for further study.

The following specific recommendations are offered:

a. Regardless of the feasibility of the proposed system, serious consideration should be given to the establishment of a group with adequate authority to serve as a central contact point to coordinate and monitor material functions among all shipyards.

b. Specific guidelines should be set forth covering control practices within shipyards so as to standardize methods of treating system stock, shop store stock, and direct material inventory.

c. A resident operations research group should be established

in the BuShips capable of studying such areas as discussed in this thesis.

d. The use of random access storage at shipyards should be investigated for purposes of integrating production planning and control and material functions in a manner similar to the PERT evaluation method discussed in this thesis as well as the possibility of incorporating real time concepts which are presently in use in the aircraft industry.

e. A test should be set up to match samplings of various materials that are deemed critical during a specified time period against current shipyard DMI's to test the feasibility of further study in the area of mutual DMI utilization on a restricted basis.

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APPENDIX A

TYPICAL NAVAL SHIPYARD ORGANIZATION

The following are listings of the primary functions performed by a naval shipyard and the typical organization (See Figure 20) to perform these functions.

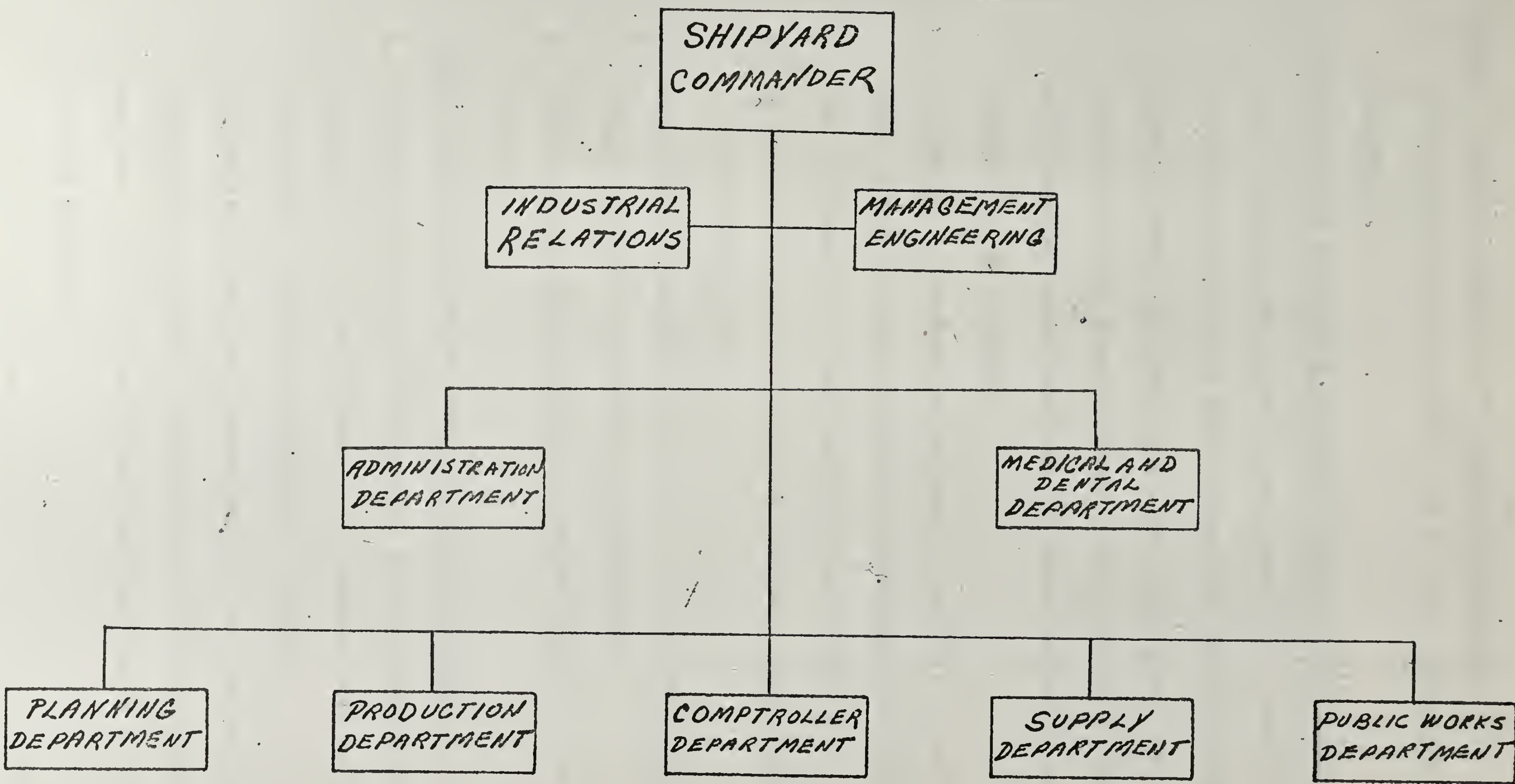
Functions

1. Construction
2. Conversion
3. Overhaul
4. Voyage Repairs and Restricted Availabilities
5. Emergency Repairs
6. Alteration Preparation
7. Manufacturing

Departments of the Naval Shipyard

1. Planning
2. Production
3. Supply
4. Comptroller
5. Public Works
6. Administration
7. Medical and Dental
8. Industrial Relations
9. Management Engineering

A description of the responsibilities of the Planning, Production, Supply, and Comptroller Departments which are the primary departments supporting the MIS Program is given below. The descriptions have been taken from the "Bureau of Ships Computer Program for Naval Shipyards--Present Status and Planned Actions." [42]



TYPICAL NAVAL SHIPYARD ORGANIZATION CHART

FIGURE 20

1. Basic responsibilities of the Planning Department are:

   a. Obtaining the necessary funds to do work authorized by customers.

   b. Authorizing all productive work (this includes approval, issue and transfer of work authorizations). Insuring that no job order is issued which authorizes the incurring of costs in excess of funds available. The authorization should be in the form of complete work specifications which provide manday and cost estimates and which are issued in timely fashion.

   c. Initiating procurement of necessary material for work in hand, including timely issue of procurement specifications.

   d. Timely issuance of plans and work specifications.

   e. Providing information on future availabilities to the Production Department.

   f. Negotiating fixed-price contracts with customers (after consulting with the Production Department).

   g. Conducting performance measurement for activities under its control.

2. Basic responsibilities of the Production Department are:

   a. Accomplishing all work authorized by the Planning Department within the time allowed in accordance with applicable instructions and sound engineering practices.

   b. Accomplishing all work authorized by the Planning Department within the total funds made available under each customer order or planning estimate applicable to each ship or project.

   c. Notifying the Planning Department, in advance of the release

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

of work on a ship or project, and based upon current and prospective workloads of the limitations or the quantity of work which can be accomplished on that ship or project.

d. Notifying the Planning Department when time or total funds are in excess of needs.

e. The overall departmental responsibility encompasses organization, administration, and supervision of the shops, facilities, and personnel.

f. Conducting performance measurement for activities under its control.

3. Basic responsibilities of the Supply Department are:

a. Maintaining sufficient material on hand to fill the normal requirements of the shipyard and satellite activities.

b. Providing material to fill requirements by the date material is required.

c. Providing ready access to high volume, low cost material by storing in convenient shop store locations.

d. Maintaining direct material inventory for use on specific jobs.

e. Making readily available accurate information on present and future availability of material.

f. Initiating action to replenish stock by reporting stock status to or requisitioning from Navy and DOD suppliers and making authorized procurements.

g. Receiving, storing, and issuing material.

h. Disposing of excess, obsolete or deteriorated material

from stock or from exchanges and returned material.

i. Conducting performance measurement for activities under its control.

4. Basic responsibilities of the Comptroller Department are:

a. Advising and consulting with the shipyard commander on all shipyard financial operations.

b. Budgeting and accounting for the shipyard monies.

c. Disbursing.

d. Financial statistical and progress reporting.

e. Auditing and analyzing the financial aspects of shipyard operations.

f. Conducting performance measurement for activities under its control.

APPENDIX B

PROGRAM AND OUTPUT FOR PEARL HARBOR GENERAL MATERIAL BREAKDOWN

Data developed by this program is accumulated in four basic forms. They are as follows: for selected shops, for total DMI, by groupings of Federal Supply Groups, and selected statistics. Unit price data is to three decimal places and money value figures are to two decimal places. The definition of abbreviated terms used in the program output are as follows:

1. LI/OH - Line items on hand.
2. SUM/UP - Sum of line item unit prices.
3. SUM/MVO - Sum of line item money value.
4. AV/UP or AVG/UP - Average line item unit price.
5. AV/MVO - Average line item money value.
6. LI/O - Line items on order.
7. STD STK - Standard Stock.
8. NSTD STK - Nonstandard Stock.
9. FSG - Federal Supply Group.
10. FREQ - Line item count.

Other terms used are self explanatory. The dates referred to for the oldest and most current requisition on hand are Julian dates.

```
      PROGRAM PEARL
      TYPE INTEGER PEARLD
      DIMENSION PEARLD(24),SHOP(11,17),ALINE(3,6),NTEST(11),CLASS(9,6),
     1OUT(9,4)
      DIMENSION JOB(2)
C     ESTABLISH NEEDED CONSTANTS
      DATA((SHOP(I,1),I=1,11)=11.,17.,26.,31.,36.,38.,41.,51.,56.,67.,
     171.)
      DATA((NTEST(I),I=1,11)=2H11,2H17,2H26,2H31,2H36,2H38,2H41,2H51,
     12H56,2H67,2H71)
C     THE FOLLOWING STATEMENTS ARE ZERO  CONTENTS FOR PURPOSES OF
C     ACCUMULATING SUMS.THESE WILL BE PULLED AFTER RUNNING FIRST TAPE.
      DATA(((CLASS(I,J),J=1,6),I=1,9)=54(0))
      DATA(((SHOP(I,J),J=2,17),I=1,11)=176(0))
      DATA(((ALINE(I,J),J=1,6),I=1,3)=18(0))
      DATA(((OUT(I,J),J=1,4),I=1,9)=36(0))
      APS=0 $APN=0$SQRPS=0 $SQRPN=0 $APRIS=0 $APRIN=0 $ REF=5084.
      OMDC=0$DMDC=0$OMSC=0$DMSC=0$ONSND=0$DNSND=0$ONSNS=0$DNSNS=0
      SUMJUL=0 $ OLD=6000.     $     CURRENT=0
      SUMSQR=0
C     THE VARIABLE MNN  WILL BE USED FOR BUFFER DO LOOP PARAMATER
C     TMNN MAINTAIN TOTAL COUNT OF RECORDS READ
C     MNN WILL BE ADJUSTED ACCORDING TO TAPE BEING BUFFERED IN
C     TAPE ONE, MNN=12611 , TMNN=0.  BUFFER  FOR TEN WORD FILE  HEADER.
C     TAPE TWO,MNN=12,957. NO HEADER LABEL.
C     TAPE THREE, MNN=4150 . BUFFER FOR TEN WORD FILE HEADER.
   18 MNN=12611  $ TMNN=0 $NCOUNT=1 $IM=2
   16 BUFFER IN (IM,0)(PEARLD(1),PEARLD(10))
  800 IF(UNIT,IM)800,15,15,15
   15 DO6I=1,MNN
      TMNN=TMNN+1.
      BUFFER IN(IM,0)(PEARLD(1),PEARLD(24))
  600 IF(UNIT,IM)1,2,3,4
    1 GO TO 600
    3 PRINT 20,I
   20 FORMAT( 3HOI= I9, 16HEOF OR EOT ERROR)
      GO TO 8
    4 PRINT 21,I
   21 FORMAT( 3HOI= I9, 12HPARITY ERROR)
      GO TO 6
    2 IF(SENSE SWITCH  5)12,32
C     SUBROUTINES FOR CONVERTING 1604 WORDS  TO USABLE FORMAT  IS DONE
C     IN  CONVERT.ROUTINE ANMBR CONVERTS FIELDS REQUIRING ARITHMETIC
C     MANIPULATION FROM BCD TO BINARY.
   32 CALL CONVERT( PEARLD,JOB,NSHOP,NFSGRP,NUI,NQTY,NUP,MVO,NCSC,
     1NCSDTE,MDC,MSC,NPRI,NQICNPR,NCONT,NCRIT,NDATE,NSYM)
      NA=8H
      DECODE(9,602, JOB)NA
  602 FORMAT(A4)
      IF(NA  .EQ. 4H9013 )12,603
  603 CALL ANMBR (NDATE,NQTY, NUP, MVO,DATE,QTY,UP,AMVO)
C     THE FOLLOWING ROUTINES ARE TO ACCUMULATE DATA FOR TABLES AND
C     FURTHER  COMPUTATION
      IF(DATE  .GT.  REF)6,670
  670 IF( MDC  .EQ.  1H5 .OR.   MDC  .EQ.  1H8)671,672
  672 OMDC=OMDC +1. $ DMDC=DMDC +AMVO
```

```
      IF(NFSGRP  .EQ.  1H    .OR.. NSYM  .GT.  12)680,671
  680 ONSND=ONSND +1.   $DNSND=DNSND+AMVO
  671 IF(MSC  .EQ.  1H8 )673,601
  673 OMSC=OMSC +1. $  DMSC=DMSC +AMVC
      IF(NFSGRP  .EQ.  1H   .OR.  NSYM   .GT.  12)674,601
  674 ONSNS=ONSNS +1.  $ DNSNS=DNSNS + AMVO
  601 CALL TABLE(SHOP,QTY,UP,AMVO,ALINE,NSHOP,MSC,NFSGRP,NCSC,NTEST,
     1NSYM)
      CALL TIME(DATE,SUMJUL,OLD,CURRENT,SUMSQR,NCSC,REF)
      CALL DISTR(CLASS,NCONT,NCRIT,NFSGRP,NCSC,OUT,DATE,REF,NSYM)
      CALL DIPRI(NPRI,APRIS,APRIN,NCSC,APS,APN,NFSGRP,DATE,REF,SQRPS,
     1SQRPN,NSYM)
    6 CONTINUE
    8 NCOUNT=NCOUNT + 1
      REWIND IM
      PAUSE 25
      IF(NCOUNT -3)30,11,12
   30 MNN=12957  $ GO TO 15
   11 MNN=4150  $  GO TO 16
   12 REWIND IM
      CALL ACCUM (SHOP,ALINE,SUMJUL,AVDTE)
      CALL FINAL(APRIS,APRIN,APS,APN,SQRPS,SQRPN,DPS,DPN)
      CALL STDEV(SUMSQR,SUMJUL,ALINE,DEVJUL)
      PRINT 690
  690 FORMAT(1H0,4X,10HNO MDC-5/8, 11X,3HMVO,9X,5HNSMDC,11X,3HMVO,
     19X,5HMSC-8,11X,3HMVO,9X,5HNSMSC,11X,3HMVO)
      PRINT 691, OMDC,DMDC,ONSND,DNSND,OMSC,DMSC,ONSNS,DNSNS
  691 FORMAT( 8F14.0)
      PRINT 692
  692 FORMAT( 1H1)
      PRINT 550
  550 FORMAT(1H0,40X,14HSTANDARD STOCK)
      PRINT 551
  551 FORMAT(5H0SHOP,7X,6HLI O/H, 9X,6HSUM/UP,8X,7HSUM/MVO,
     1 9X,6HAVG/UP,9X,6HAV/MVO,11X,4HLI/O)
      PRINT 100, ((SHOP(I,J),J=1,7),I=1,11)
  100 FORMAT(F3.0,6F15.0///)
      PRINT 552
  552 FORMAT(1H0,41X,12HNON STANDARD)
      PRINT 551
      DO 200I=1,11
      PRINT 101, SHOP(I,1),(SHOP (I,J),J=8,13)
  101 FORMAT(F3.0,6F15.0///)
  200 CONTINUE
      PRINT 553
  553 FORMAT(1H0,29X,5HTOTAL)
      PRINT 554
  554 FORMAT(1H0,11X,6HLI O/H,8X,7HSUM/MVO,9X,6HAV/MVO,11X,4HLI/O)
      DO 201I=1,11
      PRINT 105, SHOP(I,1),(SHOP(I,J),J=14,17)
  105 FORMAT(F3.0, 4F15.0///)
  201 CONTINUE
      PRINT 563
  563 FORMAT(1H0,8X,6HLI O/H,9X,6HSUM/UP,8X,7HSUM/MVO,10X,5HAV/UP,
     19X,6HAV/MVO,11X,4HLI/O)
      PRINT 102,  ((ALINE(I,J),J=1,6),I=1,3)
```

```
  102 FORMAT(6F15.0///)
      PRINT 555
  555 FORMAT(1H0,10X,4HFREQ,7X,8HCRITICAL,8X,7HCONTROL,11X,4HFREQ,
     1 7X,8HCRITICAL,8X,7HCONTROL)
      PRINT 104,((CLASS(I,J),J=1,6),I=1,9)
  104 FORMAT(6F15.0///)
      PRINT 560
  560 FORMAT(1H0,32X, 11HON/HND REQN ,20X,12HOUTSTDG REQN   )
      PRINT  561
  561 FORMAT( 1H0,25X,5H30-59 , 13X,3H60-,10X,5H30-59,12X,3H60-      )
      PRINT 562,((OUT(I,J),J=1,4),I=1,9)
  562 FORMAT(16X,4F15.0///)
      PRINT 1000,APRIS,DPS
 1000 FORMAT(29H0AVG DAYS OUTSTANDING STD STK  F11.2,5X,
     1 7HSTD DEV F11.2)
      PRINT 1001,APRIN,DPN
 1001 FORMAT(29H0AVG DAYS OUTSTANDING NON STD  F11.2,5X,
     17HSTD DEV  F11.2)
      PRINT 103, OLD, CURRENT, AVDTE
  103 FORMAT(28H0REFER REQN ON HAND--OLDEST= F1C.0,5X,
     113HMOST CURRENT=  F10.0,5X,13HAVG DAY HELD=  F10.2)
      PRINT 108,DEVJUL
  108 FORMAT(21H0STD DEV FOR AVG DATE     F10.2///)
  500 END

      SUBROUTINE CONVERT(PEARLD,JOB,NSHOP,NFSGRP,NUI,NQTY,NUP,MVC,
     1NCSC,NCSDTE,MDC,MSC,NPRI,NQICNPR,NCONT,NCRIT,NDATE,NSYM)
      TYPE INTEGER  PEARLD
      DIMENSION PEARLD(24)
      DIMENSION JOB(2)
      ENCODE(9,100,JOB)PEARLD(1),PEARLD(2)
  100 FORMAT(A8,A1)
      DECODE (8,101,PEARLD(2))NSHOP,NDATE
  101 FORMAT (1X,A2,A4)
      NC=8H
      DECODE(8,1,NDATE)NC
    1 FORMAT(A1)
      IF(NC .EQ. 1HC)14,15
   14 DATE=4H2182   $ GO TO 15
   15 DECODE(8,104,PEARLD(5))NFSGRP
  104 FORMAT (3X,A2)
      DECODE(8,106,PEARLD(7))NUI
  106 FORMAT (2X,A2)
      DECODE(8,108,PEARLD(7))NTEMP1
  108 FORMAT (4X,A4)
      ENCODE (5,109,NQTY)NTEMP1,PEARLD(8)
  109 FORMAT (A4,A1)
      DECODE(8,110,PEARLD(8))NTEMP1
  110 FORMAT (1X,A7)
      ENCODE (8,111,NUP)NTEMP1,PEARLD(9)
  111 FORMAT (A7,A1)
      DECODE(8,112,PEARLD(9))NTEMP1
  112 FORMAT(1X,A7)
      ENCODE(8,113,MVO)NTEMP1,PEARLD(10)
  113 FORMAT (A7,A1)
      DECODE(8,114,PEARLD(10))NCSC
  114 FORMAT(1X,A2)
      DECODE(8,115,PEARLD(10))NCSDTE
  115 FORMAT (3X,A4)
      DECODE (8,120,PEARLD(15))MDC
  120 FORMAT(A1)
      DECODE (8,121,PEARLD(15))MSC
  121 FORMAT(3X,A1)
      DECODE(8,122,PEARLD(18))NPRI
  122 FORMAT(2X,A2)
      DECODE(8,123,PEARLD(20))NQICNPR
  123 FORMAT (4X,A2)
      DECODE(8,124,PEARLD(20))NCONT
  124 FORMAT(6X,A1)
      DECODE(8,125,PEARLD(20))NCRIT
  125 FORMAT(7X,A1)
      DECODE(8,2,PEARLC(5))NSYM
    2 FORMAT(7X,R1)
      RETURN
      END
```

```
      SUBROUTINE ANMBR(NDATE,NQTY,NUP,MVO,DATE,QTY,UP,AMVO)
      DIMENSION INPUT (8)
      NN=0
      NWORK=NDATE   $ N=4 $ J=4 $ GO TO 10
   20 NWORK=NQTY    $ N=5 $ J=5 $ GO TO 10
   21 NWORK=NUP     $ N=8 $ J=8 $ GO TO 10
   22 NWORK=MVO     $ N=8 $ J=8 $ GO TO 10
   10 AVAR=0
      DO 1I=1,N
      ENCODE(5,2,MOR)J
    2 FORMAT(1H( I1,3HR1))
      DECODE(J,MOR,NWORK)(INPUT(L),L=1,J)
      IF (INPUT(I) .EQ. 1RO .OR. INPUT(I) .EQ. 1R  )30,31
   30 INPUT(I)=0
   31 AVAR=AVAR*10.
      ADD=INPUT(I)
    1 AVAR=AVAR + ADD
      IF(NN .EQ. 0) 50,11
   50 DATE =AVAR  $NN=NN+1  $ GO TO 20
   11 IF(NN .EQ.1)12,13
   12 QTY=AVAR $ NN=NN+1  $ GO TO 21
   13 IF(NN .EQ.2)14,15
   14 UP=AVAR   $ NN=NN+1  $ GO TO 22
   15 AMVO=AVAR
      IF(DATE   .LT. 2182.  .OR. DATE.GT. 5084.)26,25
   26 DATE=6000.
   25 RETURN
      END
```

```
      SUBROUTINE DISTR(CLASS,NCONT,NCRIT,NFSGRP,NCSC,OUT,DATE,REF,NSYM)
      DIMENSION  CLASS(9,6),INPUT(2),OUT(9,4)
      IF(NFSGRP  .EQ. 2H   .OR. NSYM .GT. 12)1,2
    1 RETURN
    2 DECODE(4,3,NFSGRP)(INPUT(I),I=1,2)
    3 FORMAT(2R1)
      NGRP=0
      DO 4I=1,2
      IF(INPUT(I) .EQ. 1RO .OR. INPUT (I)  .EQ.  1R  )100,101
  100 INPUT(I)=0
  101 NGRP=10* NGRP
    4 NGRP=NGRP+INPUT(I)
      N=10
      DO 20 I=1,9
      N=N+10
      IF(NGRP .LT. N)21,20
C     CHECK FOR ON ORDER
   21 IF(NCSC .EQ. 2HNS .OR. NCSC .EQ. 2HD2)22,23
   23 J=1 $ NN=0  $ NNN=0
      IF(REF-DATE .GE. 30.)80,29
   80 IF(REF-DATE .LT.  60.)81,82
   81 OUT(I,1)=OUT(I,1) +1.  $ GO TO 29
   82 OUT(I,2)=OUT(I,2) + 1.
   29 CLASS(I,J)=CLASS(I,J)+1.
      IF(NCRIT  .EQ. 1H    )25,26
   26 CLASS(I,NN+2)=CLASS(I,NN+2)+1.
   25 IF(NCONT  .EQ. 1H  )50,28
   28 CLASS(I,NNN+3)=CLASS(I,NNN+3)+1.  $ GO TO 50
   22 J=4 $NN=3  $NNN= 3
      IF(REF-DATE  .GE. 30.)70,29
   70 IF(REF-DATE .LT. 60.)72,73
   72 OUT(I,3)=OUT(I,3) +1.  $ GO TO 29
   73 OUT(I,4) = OUT(I,4) + 1.  $ GO TO 29
   20 CONTINUE
   50 RETURN
      END
```

```
      SUBROUTINE TIME(DATE,SUMJUL,OLD,CURRENT,SUMSQR,NCSC,REF)
      IF (NCSC .EQ.2HNS .OR. NCSC .EQ. 2HD2)5,6
    6 IF(DATE .GT. CURRENT)1,2
    1 CURRENT=DATE $ GO TO 4
    2 IF(DATE  .LT. OLD)3,4
    3 OLD=DATE
    4 IF( DATE .LT. 2000.)600,601
  600 ATEMP=1365. -DATE
      ATEMP=ATEMP+1095. +REF-5000.
      GO TO 7
  601 IF(DATE .LT. 3000.) 602,603
  602 ATEMP=2365-DATE
      ATEMP=ATEMP +730. + REF-5000.
      GO TO 7
  603 IF(DATE .LT. 4000.)604,605
  604 ATEMP=3365. -DATE
      ATEMP=ATEMP +365. +REF -5000.
      GO TO 7
  605 IF(DATE .LT. 5000.)606,607
  606 ATEMP=4365. -DATE
      ATEMP =ATEMP +REF- 5000.
      GO TO 7
  607 ATEMP= REF-DATE
    7 SUMJUL=SUMJUL+ATEMP
      SUMSQR=SUMSQR+ATEMP*ATEMP
    5 RETURN
      END

      SUBROUTINE TABLE (SHOP,QTY,UP,AMVO,ALINE,NSHOP,MSC,NFSGRP,NCSC,
     1NTEST,NSYM)
      DIMENSION SHOP(11,17),ALINE(3,6),NTEST(11)
C     CHECK FOR SHOP NUMBER
      DO 21 I=1,11
      IF(NTEST(I) .EQ.  NSHOP)20,21
   21 CONTINUE
C     CHECK IF STD STK .IF STD,M=1. IF NONSTD,M=2
   60 IF(NFSGRP  .EQ. 2H    .OR.  NSYM .GT. 12 )30,31
   31 M=1$GO TO 32
   30 M=2
C     CHECK IF ON ORDER
   32 IF(NCSC .EQ. 2HNS .OR. NCSC .EQ. 2HD2 )33,34
   33 ALINE(M,6)=ALINE(M,6) +1.  $ GO TO 35
   34 ALINE(M,1)=ALINE(M,1)+1.
      ALINE(M,2)=ALINE(M,2)+UP
      ALINE(M,3)=ALINE(M,3)+AMVO
   35 RETURN
C     ACCUMULATE BY DESIGNATED SHOP
C     IF STD STK , M=7. IF NON STD, M=13.
   20 IF(NFSGRP  .EQ. 2H    .OR. NSYM .GT. 12)50,51
   51 M=7 $ GO TO 52
   50 M=13
C     CHECK IF ON ORDER
   52 IF(NCSC .EQ. 2HNS .OR. NCSC .EQ. 2HD2)53,54
   53 SHOP(I,M)=SHOP(I,M) +1. $ SHOP(I,17)=SHOP(I,17) +1. $ GO TO 60
C     CHECK FOR STD AND NON STD. M=2 FOT STD AND M=8 FOR NON STD..
   54 IF(M .EQ. 7)55,56
   55 M=2  $ GO TO 57
   56 M=8
   57 SHOP(I,M)=SHOP(I,M)+1.
      SHOP(I,M+1)=SHOP(I,M+1) +UP
      SHOP(I,M+2)=SHOP(I,M+2)+AMVO
      SHOP(I,14)=SHOP(I,14)+1.
      SHOP(I,15)=SHOP(I,15)+AMVO
      GO TO 60
      END
```

```
      SUBROUTINE  ACCUM( SHOP,ALINE, SUMJUL,AVDTE )
      DIMENSION   SHOP(11,17),ALINE(3,6)
      DO 1 N=1,11
      SHOP(N,5)=SHOP(N,3)/SHOP(N,2)
      SHOP(N,6)=SHOP(N,4)/SHOP(N,2)
      SHOP(N,11)=SHOP(N,9)/SHOP(N,8)
      SHOP(N,12)=SHOP(N,10)/SHOP(N,8)
    1 SHOP(N,16)=SHOP(N,15)/SHOP(N,14)
      DO 2N=1,2
      ALINE(N,4)=ALINE(N,2)/ALINE(N,1)
    2 ALINE(N,5)=ALINE(N,3)/ALINE(N,1)
      ALINE(3,1)=ALINE(1,1)+ALINE(2,1)
      ALINE(3,2)=ALINE(1,2)+ALINE(2,2)
      ALINE(3,3)=ALINE(1,3) +ALINE(2,3)
      ALINE(3,4)=ALINE(3,2)/ALINE(3,1)
      ALINE(3,5)=ALINE(3,3)/ALINE(3,1)
      ALINE(3,6)=ALINE(1,6)+ALINE(2,6)
      AVDTE=SUMJUL/ALINE(3,1)
      RETURN
      END

      SUBROUTINE DIPRI(NPRI,APRIS,APRIN,NCSC,APS,APN,NFSGRP,DATE,REF,
     1SQRPS,SQRPN,NSYM)
C     REFERENCE DATE IS OBTAINED FROM MOST CURRENT REQN DATE DETERMINED
C     FROM PREVIOUS RUNS, AND WILL BE CALLED REF.
      IF(NCSC .EQ. 2HD2 .OR. NCSC .EQ. 2HNS )4,500
    4 IF( DATE .LT. 2000.)600,601
  600 ATEMP=1365. -DATE
      ATEMP=ATEMP+1095. +REF-5000.
      GO TO 7
  601 IF(DATE .LT. 3000.) 602,603
  602 ATEMP=2365-DATE
      ATEMP=ATEMP +730. + REF-5000.
      GO TO 7
  603 IF(DATE .LT. 4000.)604,605
  604 ATEMP=3365. -DATE
      ATEMP=ATEMP +365. +REF -5000.
      GO TO 7
  605 IF(DATE .LT. 5000.)606,607
  606 ATEMP=4365. -DATE
      ATEMP =ATEMP +REF- 5000.
      GO TO 7
  607 ATEMP= REF-DATE
    7 IF(NFSGRP  .EQ.  2H   .OR.  NSYM  .GT.  12)3,8
    8 APS=APS+1.
      IF( DATE    .GE. REF)100,101
  100 APS=APS-1.$ GO TO 500
  101 APRIS=APRIS+ATEMP $SQRPS=SQRPS+ATEMP*ATEMP $ GO TO 500
    3 IF(DATE   .GE.  REF)500,5
    5 APN=APN+1.
      APRIN=APRIN+ATEMP  $SQRPN=SQRPN+ATEMP*ATEMP
  500 RETURN
      END

      SUBROUTINE FINAL (APRIS,APRIN,APS,APN,SQRPS,SQRPN,DPS,DPN)
      DPS=SQRTF(SQRPS/APS-(APRIS*APRIS)/(APS*APS))
      DPN=SQRTF(SQRPN/APN-(APRIN*APRIN)/(APN*APN))
      APRIS=APRIS/APS
      APRIN=APRIN/APN
      RETURN
      END

      SUBROUTINE STDEV (SUMSQR,SUMJUL,ALINE,DEVJUL)
      DIMENSION ALINE(3,6)
      DEVJUL=SQRTF(SUMSQR/ALINE(3,1)-(SUMJUL*SUMJUL)/(ALINE(3,1)*
     1ALINE(3,1)))
      RETURN
      END
```

PEARL HARBOR
STANDARD STOCK

SHOP	LI O/H	SUM/UP	SUM/MVO	AVG/UP	AV/MVO	LI/O
11	314	14529910	3937077	46274	12538	153
17	430	15495810	3161710	36032	7353	113
26	52	80530	1168046	1549	22847	12
31	2269	105197141	18552129	46363	8176	347
36	0	0	0	0	0	0
38	2522	69521030	13565290	27566	5379	478
41	135	1655732	1832025	12265	13571	27
51	1266	36014557	8047402	28448	6357	662
56	2725	62616771	33360030	22979	12242	620
67	2005	23550263	4317931	11746	2154	930
71	17	416569	649363	24504	38198	19

NON STANDARD

SHOP	LI O/H	SUM/UP	SUM/MVO	AVG/UP	AV/MVO	LI/O
11	38	2046187	694031	53073	18264	91
17	53	3147971	1693853	59396	31959	51
26	16	44401	1396931	2775	87308	22
31	170	17924163	3643930	105436	21435	290
36	0	0	0	0	0	0
38	149	54842115	18585348	368068	124734	220
41	14	1917963	728760	136997	51840	1
51	139	13168613	2768005	94738	19914	309
56	1222	107056364	42491783	87607	34772	2103
67	147	5388693	1130068	36658	7688	297
71	81	936637	5758866	11563	71097	33

TOTAL

SHOP	LI O/H	SUM/MVO	AV/MVO	LI/O
11	352	4631108	13157	244
17	483	4855563	10053	164
26	68	2584977	38014	34
31	2439	22196059	9100	637
36	0	0	0	0
38	2671	32150638	12037	698
41	149	2557785	17166	28
51	1405	10815407	7698	971
56	3947	75851813	19218	2723
67	2152	5447999	2532	1227
71	98	6408229	65390	52

PEARL HARBOR
COLLECTIVE DMI DATA

	LI O/H	SUM/UP	SUM/MVO	AV/UP	AV/MVO	LI/O
STD STK	12282	340049611	92306947	27687	7516	3995
NSTD STK	2196	610205770	120791118	277871	55005	4004
TOTAL	14478	950255381	213098065	65634	14719	7999

STD STK
FSG DISTRIBUTION

FSG	O/H FREQ	CRITICAL	CONTROL	LI/O FREQ	CRITICAL	CONTROL
-19	739	0	0	202	0	0
20-29	721	0	0	182	0	0
30-39	782	0	0	196	0	0
40-49	3337	0	0	790	0	0
50-59	5348	0	0	1737	0	0
60-69	724	0	0	576	0	0
70-79	112	0	0	42	0	0
80-89	59	0	0	49	0	0
90-99	460	0	0	221	0	0

30 DAYS OR MORE FSG DISTRIBUTION

FSG	ON/HND REQN 30-59	ON/HND REQN 60-	OUTSIDE REQN 30-59	OUTSIDE REQN 60-
-19	6	513	8	162
20-29	116	573	38	81
30-39	115	603	50	89
40-49	538	2560	195	331
50-59	734	4155	313	548
60-69	104	576	129	249
70-79	8	100	14	14
80-89	9	30	8	30
90-99	63	319	25	58

AVG DAYS OUTSTANDING STD STK 72.69 STD DEV 77.01
AVG DAYS OUTSTANDING NON STD 70.88 STD DEV 67.55
REFER REQN ON HAND--OLDEST= 2235 MOST CURRENT= 5084 AVG DAY HELD= 152.40
STD DEV FOR AVG DATE 109.22

APPENDIX C

PROGRAM AND OUTPUT FOR
PEARL HARBOR FINE MATERIAL BREAKDOWN, SAMPLING

Data developed by this program is accumulated by Federal Supply Group for 12,716 of the 16,277 DMI standard stock material on hand and on order records. A further breakdown is made showing this data in 30 day increments between 60 and 179 days. The definition of abbreviated terms used in the program output are as follows:

1. FSG - Federal Supply Group.
2. O/H - Line items on hand.
3. ON ORDR - Line items of standard stock on order.
4. STD - Standard stock.

```
      PROGRAM PEARL
      TYPE INTEGER PEARLD
      DIMENSICN PEARLD(24),CLASS(100,3),OUT(100,13)
C     ESTABLISH NEEDED CONSTANTS
C     THE FOLLOWING STATEMENTS ARE ZERO  CONTENTS FOR PURPOSES CF
C     ACCUMULATING SUMS.THESE WILL BE PULLED AFTER RUNNING FIRST TAPE.
      DO 900 I=1,100
      CLASS(I,1)=I   $ CLASS(I,2)=0 $ CLASS(I,3)=0
  900 OUT(I,1)=I
      DO 901 I=1,100
      DO 901 J=2,13
  901 OUT(I,J)=0
C     THE VARIABLE MNN  WILL BE USED FOR BUFFER DO LOOP PARAMATER
C     TMNN MAINTAIN TOTAL COUNT OF RECORDS READ
C     MNN WILL BE ADJUSTED ACCORDING TO TAPE BEING BUFFERED IN
C     TAPE CNE, MNN=12611 , TMNN=0.  BUFFER  FOR TEN WORD FILE  HEADER.
C     TAPE TWO,MNN=12,957. NO HEADER LABEL.
C     TAPE THREE, MNN=4150 . BUFFER FOR TEN WORD FILE HEADER.
      REF=5084.    $ TMNN=0
   18 MNN=12611  $ TMNN=0 $NCOUNT=1 $IM=2
   16 BUFFER IN (IM,0)(PEARLD(1),PEARLD(10))
  800 IF(UNIT,IM)800,15,15,15
   15 DO6I=1,MNN
      TMNN=TMNN+1.
      BUFFER IN(IM,0)(PEARLD(1),PEARLD(24))
  600 IF(UNIT,IM)1,2,3,4
    1 GO TO 600
    3 PRINT 20,I
   20 FORMAT( 3HOI= I9, 16HEOF OR EOT ERROR)
      GO TO 8
    4 PRINT 21,I
   21 FORMAT( 3HOI= I9, 12HPARITY ERROR)
      GO TO 6
    2 II=LENGTHF(IM)
      IF(II.EQ.10)6,7
    7 IF(II.EQ.24)10,9
    9 PRINT 22,I
   22 FORMAT( 3HOI=I9,19HRECORD LENGTH ERROR)
      GO TO 6
   10 IF(SENSE SWITCH  5)12,32
C     SUBROUTINES FOR CONVERTING 1604 WORDS  TO USABLE FORMAT  IS DONE
C     IN  CONVERT.ROUTINE ANMBR CONVERTS FIELDS REQUIRING ARITHMETIC
C     MANIPULATION FROM BCD TO BINARY.
   32 CALL CONVERT( PEARLD,JOB,NSHOP,NFSGRP,NUI,NQTY,NUP,MVO,NCSC,
     1NCSDTE,MCC,MSC,NPRI,NQICNPR,NCONT,NCRIT,NDATE,NSYM)
      NA=8H
      DECODE(9,602, JOB)NA
  602 FORMAT(A4)
      IF(NA  .EQ. 4H9013 )12,603
  603 CALL ANMBR (NDATE,NQTY, NUP, MVO,DATE,QTY,UP,AMVO)
C     THE FOLLOWING ROUTINES ARE TO ACCUMULATE DATA FOR TABLES AND
C     FURTHER  COMPUTATION
      IF(DATE .GT. REF)6,601
  601 CALL DISTR(CLASS,NCONT,NCRIT,NFSGRP,NCSC,OUT,DATE,REF,NSYM)
    6 CONTINUE
    8 NCOUNT=NCOUNT + 1
```

```
      REWIND IM
      PAUSE 25
      IF(NCOUNT -3)30,11,12
  30  MNN=12957  $ GO TO 15
  11  MNN=4150  $  GO TO 16
  12  REWIND IM
      PRINT 551
 551  FORMAT(1HO,3HFSG, 12X ,3HO/H,8X,   7HON ORDR )
      PRINT 552, ((CLASS(I,J),J=1,3),I=1,100)
 552  FORMAT(F4.0,2F15.0/)
      PRINT 550
 550  FORMAT(1HO,40X,11HSTD ON HAND)
      PRINT 553
 553  FORMAT(1HO,3HFSG,12X,3H-59,10X ,5H60-89,  9X,6H90-119,8X,
     17H120-149,  8X,7H150-179, 11X ,4H180-)
      PRINT 554,  ((OUT(I,J),J=1,7),I=1,100)
 554  FORMAT(F4.0,6F15.0/)
      PRINT 555
 555  FORMAT(1HO,40X, 12HSTD ON ORDER)
      PRINT 553
      DO 557 I=1,100
      PRINT 556,OUT(I,1),(OUT(I,J),J=8,13)
 556  FORMAT(F4.0,6F15.0/)
 557  CONTINUE
 500  END

      SUBROUTINE CONVERT(PEARLD,JOB,NSHOP,NFSGRP,NUI,NQTY,NUP,MVO,
     1NCSC,NCSDTE,MDC,MSC,NPRI,NQICNPR,NCONT,NCRIT,NDATE,NSYM)
      TYPE INTEGER  PEARLD
      DIMENSION PEARLD(24)
      ENCODE(9,100,JOB)PEARLD(1),PEARLD(2)
 100  FORMAT(A8,A1)
      DECODE (8,101,PEARLD(2))NSHOP,NDATE
 101  FORMAT (1X,A2,A4)
      NC=8H
      DECODE(8,1,NDATE)NC
   1  FORMAT(A1)
      IF(NC .EQ. 1HC)14,15
  14  DATE=4H2182   $ GO TO 15
  15  DECODE(8,104,PEARLD(5))NFSGRP
 104  FORMAT (3X,A2)
      DECODE(8,106,PEARLD(7))NUI
 106  FORMAT (2X,A2)
      DECODE(8,108,PEARLD(7))NTEMP1
 108  FORMAT (4X,A4)
      ENCODE (5,109,NQTY)NTEMP1,PEARLD(8)
 109  FORMAT (A4,A1)
      DECODE(8,110,PEARLD(8))NTEMP1
 110  FORMAT (1X,A7)
      ENCODE (8,111,NUP)NTEMP1,PEARLD(9)
 111  FORMAT (A7,A1)
      DECODE(8,112,PEARLD(9))NTEMP1
 112  FORMAT(1X,A7)
      ENCODE(8,113,MVO)NTEMP1,PEARLD(10)
 113  FORMAT (A7,A1)
      DECODE(8,114,PEARLD(10))NCSC
 114  FORMAT(1X,A2)
      DECODE(8,115,PEARLD(10))NCSDTE
 115  FORMAT (3X,A4)
      DECODE (8,120,PEARLD(15))MDC
 120  FORMAT(A1)
      DECODE (8,121,PEARLD(15))MSC
 121  FORMAT(3X,A1)
      DECODE(8,122,PEARLD(18))NPRI
 122  FORMAT(2X,A2)
      DECODE(8,123,PEARLD(20))NQICNPR
 123  FORMAT (4X,A2)
      DECODE(8,124,PEARLD(20))NCONT
 124  FORMAT(6X,A1)
      DECODE(8,125,PEARLD(20))NCRIT
 125  FORMAT(7X,A1)
      DECODE(8,2,PEARLD(5))NSYM
   2  FORMAT(7X,R1)
      RETURN
      END
```

```
      SUBROUTINE ANMBR(NDATE,NQTY,NUP,MVO,DATE,QTY,UP,AMVO)
      DIMENSION INPUT (8)
      NN=0
      NWORK=NDATE    $ N=4  $ J=4  $ GO TO 10
   20 NWORK=NQTY     $ N=5  $ J=5  $ GO TO 10
   21 NWORK=NUP      $ N=8  $ J=8  $ GO TO 10
   22 NWORK=MVO      $ N=8  $ J=8  $ GO TO 10
   10 AVAR=0
      DO 1I=1,N
      ENCODE(5,2,MOR)J
    2 FORMAT(1H( I1,3HR1))
      DECODE(J,MOR,NWORK)(INPUT(L),L=1,J)
      IF (INPUT(I) .EQ. 1RO .OR. INPUT(I) .EQ. 1R  )30,31
   30 INPUT(I)=0
   31 AVAR=AVAR*10.
      ADD=INPUT(I)
    1 AVAR=AVAR + ADD
      IF(NN .EQ. 0) 50,11
   50 DATE =AVAR  $NN=NN+1   $ GO TO 20
   11 IF(NN .EQ.1)12,13
   12 QTY=AVAR $ NN=NN+1   $ GO TO 21
   13 IF(NN .EQ.2)14,15
   14 UP=AVAR   $ NN=NN+1   $ GO TO 22
   15 AMVO=AVAR
      IF(DATE  .LT. 2182.  .OR. DATE.GT. 5084.)26,25
   26 DATE=6000.
   25 RETURN
      END

      SUBROUTINE DISTR(CLASS,NCONT,NCRIT,NFSGRP,NCSC,OUT,DATE,REF,NSYM)
      DIMENSION CLASS (100,3), OUT(100,13),INPUT(2)
      IF(NFSGRP  .EQ. 2H   .OR. NSYM .GT. 12)1,2
    1 RETURN
    2 DECODE(4,3,NFSGRP)(INPUT(I),I=1,2)
    3 FORMAT(2R1)
      NGRP=0
      DO 4I=1,2
      IF(INPUT(I) .EQ. 1RO .OR. INPUT (I)  .EQ.  1R  )100,101
  100 INPUT(I)=0
  101 NGRP=10* NGRP
    4 NGRP=NGRP+INPUT(I)
      IF(DATE .LT. 4000.)50,51
   50 TEMP=200.  $ GO TO 54
   51 IF(DATE  .LT. 5000.)52,53
   52 TEMP=4365.-DATE
      TEMP=TEMP+REF-5000.   $ GO TO 54
   53 TEMP=REF-DATE
   54 DO 20 I=1,100
      IF(NGRP   .EQ. I)18,20
   18 IF(NCSC  .EQ. 2HNS  .OR. NCSC  .EQ. 2HD2 ) 22,23
   22 J=3   $NN=6  $  GO TO 41
   23 J=2  $  NN=0
   41 N=30
      DO 40 JA=2,6
      JJ=JA+NN
      N=N+30
      IF( TEMP    .LT. N) 30,40
   30 OUT(I,JJ)=OUT(I,JJ)+1.  $ GO TO 42
   40 CONTINUE
      OUT(I,JJ+1)=OUT(I,JJ+1)+1.
   42 CLASS(I,J)=CLASS(I,J)+1.  $ GO TO 25
   20 CONTINUE
   25 RETURN
      END
```

PEARL HARBOR SAMPLING

FSG	O/H	ON ORDR	FSG	O/H	ON ORDR
1	42	4	50	0	0
2	4	106	51	15	15
3	1	4	52	1	1
4	0	0	53	2780	459
5	0	2	54	0	0
6	0	12	55	3	5
7	0	0	56	37	16
8	0	0	57	0	0
9	0	0	58	193	186
10	597	44	59	1534	483
11	0	0	60	0	0
12	24	4	61	212	146
13	2	3	62	55	66
14	0	2	63	15	3
15	0	0	64	0	0
16	6	5	65	0	2
17	2	1	66	277	98
18	0	0	67	0	3
19	0	0	68	41	43
20	170	35	69	3	0
21	0	0	70	0	0
22	0	0	71	31	5
23	0	0	72	38	4
24	0	0	73	29	11
25	7	2	74	1	1
26	0	0	75	2	8
27	0	0	76	0	0
28	408	65	77	0	0
29	84	18	78	0	0
30	102	33	79	2	1
31	568	98	80	29	25
32	0	0	81	6	9
33	0	0	82	0	1
34	48	12	83	2	0
35	12	5	84	0	0
36	0	0	85	0	1
37	0	0	86	0	0
38	0	0	87	0	0
39	9	5	88	0	0
40	15	7	89	0	0
41	161	21	90	0	0
42	12	7	91	26	14
43	593	91	92	0	0
44	117	26	93	40	16
45	81	18	94	0	0
46	13	4	95	199	61
47	963	209	96	2	1
48	476	122	97	0	0
49	4	4	98	0	0
			99	4	0

PEARL HARBOR SAMPLING
STD ON HAND

FSG	-59	60-89	90-119	120-149	150-179	180-
1	0	0	0	0	42	0
2	0	0	0	0	4	0
3	0	0	0	0	0	1
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	0	0	0	0	0	0
7	0	0	0	0	0	0
8	0	0	0	C	0	0
9	0	0	0	0	0	0
10	154	79	283	73	4	4
11	0	0	0	0	0	0
12	4	0	7	13	0	0
13	1	0	0	1	0	0
14	0	0	0	0	0	0
15	0	0	0	0	0	0
16	4	0	0	2	0	0
17	0	0	0	2	0	0
18	0	0	0	0	0	0
19	0	0	0	0	0	0
20	17	14	6	15	11	107
21	0	0	0	0	0	0
22	0	0	0	0	0	0
23	0	0	0	0	0	0
24	0	0	0	0	0	0
25	0	1	1	1	1	3
26	0	0	0	0	0	0
27	0	0	0	0	0	0
28	88	0	103	84	27	106
29	8	0	4	51	8	13
30	16	5	17	33	4	27
31	124	29	131	143	32	109
32	0	0	0	0	0	0
33	0	0	0	0	0	0
34	18	16	9	2	3	0
35	1	0	4	7	0	0
36	0	0	0	0	0	0
37	0	0	0	0	0	0
38	0	0	0	0	0	0
39	2	0	0	6	0	1
40	6	1	2	0	0	6
41	40	0	70	1	42	8
42	2	0	1	0	0	9
43	78	3	47	133	17	315
44	16	1	4	37	12	47
45	5	2	0	12	10	52
46	2	1	8	1	0	1
47	168	105	80	95	34	481
48	85	44	41	75	49	182
49	0	0	0	0	1	3

PEARL HARBOR SAMPLING
STD ON HAND

FSG	-59	60-89	90-119	120-149	150-179	180-
50	0	0	0	0	0	0
51	3	3	1	1	0	7
52	0	1	0	0	0	0
53	501	179	555	625	233	687
54	0	0	0	0	0	0
55	1	1	0	0	0	1
56	5	1	2	2	1	26
57	0	0	0	0	0	0
58	53	5	8	94	11	22
59	410	71	81	382	204	386
60	0	0	0	0	0	0
61	54	19	14	52	23	50
62	12	2	10	9	14	8
63	0	0	2	0	0	13
64	0	0	0	0	0	0
65	0	0	0	0	0	0
66	27	4	41	89	22	94
67	0	0	0	0	0	0
68	8	2	8	12	2	9
69	0	0	0	0	2	1
70	0	0	0	0	0	0
71	3	0	1	1	1	25
72	1	1	0	2	2	32
73	2	0	4	15	2	6
74	0	0	0	0	0	1
75	0	0	0	1	1	0
76	0	0	0	0	0	0
77	0	0	0	0	0	0
78	0	0	0	0	0	0
79	0	2	0	0	0	0
80	17	2	4	2	2	2
81	2	0	0	0	0	4
82	0	0	0	0	0	0
83	2	0	0	0	0	0
84	0	0	0	0	0	0
85	0	0	0	0	0	0
86	0	0	0	0	0	0
87	0	0	0	0	0	0
88	0	0	0	0	0	0
89	0	0	0	0	0	0
90	0	0	0	0	0	0
91	7	1	1	13	0	4
92	0	0	0	0	0	0
93	5	0	11	11	2	11
94	0	0	0	0	0	0
95	43	30	16	13	4	93
96	1	1	0	0	0	0
97	0	0	0	0	0	0
98	0	0	0	0	0	0
99	0	0	2	0	0	2

PEARL HARBOR SAMPLING
STC CN ORDER

FSG	-59	60-89	90-119	120-149	150-179	180-
1	1	0	0	0	3	0
2	1	1	5	27	71	1
3	0	0	0	2	2	0
4	0	0	0	0	0	0
5	0	0	0	0	2	0
6	0	0	0	0	12	0
7	0	0	0	0	0	0
8	0	0	0	0	0	0
9	0	0	0	0	0	0
10	25	2	4	5	5	3
11	0	0	0	0	0	0
12	0	1	2	0	0	1
13	0	0	0	0	0	3
14	0	0	0	0	1	1
15	0	0	0	0	0	0
16	3	2	0	0	0	0
17	0	0	0	1	0	0
18	0	0	0	0	0	0
19	0	0	0	0	0	0
20	8	4	2	5	5	11
21	0	0	0	0	0	0
22	0	0	0	0	0	0
23	0	0	0	0	0	0
24	0	0	0	0	0	0
25	1	1	0	0	0	0
26	0	0	0	0	0	0
27	0	0	0	0	0	0
28	38	7	9	7	2	2
29	4	1	4	7	0	2
30	17	5	1	4	0	6
31	54	6	8	17	9	4
32	0	0	0	0	0	0
33	0	0	0	0	0	0
34	3	4	2	2	1	0
35	1	1	2	0	0	1
36	0	0	0	0	0	0
37	0	0	0	0	0	0
38	0	0	0	0	0	0
39	3	0	0	2	0	0
40	7	0	0	0	0	0
41	12	1	4	0	1	3
42	2	1	0	1	1	2
43	60	9	5	12	1	4
44	17	2	3	2	1	1
45	10	1	3	4	0	0
46	3	0	1	0	0	0
47	130	31	7	13	5	23
48	62	17	8	12	9	14
49	0	1	0	2	0	1

PEARL HARBOR SAMPLING
STD ON ORDER

FSG	-59	60-89	90-119	120-149	150-179	180-
50	0	0	0	0	0	0
51	5	0	0	2	4	4
52	0	1	0	0	0	0
53	329	38	26	30	5	31
54	0	0	0	0	0	0
55	3	1	0	1	0	0
56	4	0	5	1	0	6
57	0	0	0	0	0	0
58	162	14	1	5	1	3
59	250	23	17	32	29	132
60	0	0	0	0	0	0
61	78	15	19	11	5	18
62	29	2	6	4	10	15
63	1	0	1	0	0	1
64	0	0	0	0	0	0
65	0	0	1	1	0	0
66	61	9	10	7	6	5
67	0	1	0	1	1	0
68	17	4	4	6	3	9
69	0	0	0	0	0	0
70	0	0	0	0	0	0
71	2	0	1	1	0	1
72	2	0	0	0	1	1
73	8	1	1	0	0	1
74	1	0	0	0	0	0
75	6	0	0	1	0	1
76	0	0	0	0	0	0
77	0	0	0	0	0	0
78	0	0	0	0	0	0
79	0	0	1	0	0	0
80	13	4	5	2	0	1
81	2	0	0	3	1	3
82	0	0	0	1	0	0
83	0	0	0	0	0	0
84	0	0	0	0	0	0
85	0	1	0	0	0	0
86	0	0	0	0	0	0
87	0	0	0	0	0	0
88	0	0	0	0	0	0
89	0	0	0	0	0	0
90	0	0	0	0	0	0
91	6	0	2	2	1	3
92	0	0	0	0	0	0
93	11	0	0	2	1	2
94	0	0	0	0	0	0
95	40	7	7	0	0	7
96	1	0	0	0	0	0
97	0	0	0	0	0	0
98	0	0	0	0	0	0
99	0	0	0	0	0	0

APPENDIX D

OUTPUT FOR PEARL HARBOR
FINE MATERIAL BREAKDOWN, TOTAL

The program used in this run is the same as shown in Appendix C. However, the total DMI file was analyzed.

Data shown in the program output was accumulated by Federal Supply Group for standard stock material on hand and on order. A further breakdown is made showing the data in 30 day increments between 60 and 179 days. The definition of abbreviated terms used in the program output are as follows:

1. FSG - Federal Supply Group.
2. O/H - Line items on hand.
3. ON ORDER - Line items of standard stock on order.
4. STD - Standard stock.

[illegible]

[illegible]
[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

FSG	C/H	PEARL HARBOR TOTAL ON ORDER	FSG	C/H	ON ORDER
1	42	4	50	C	0
2	4	108	51	15	22
3	1	4	52	1	1
4	C	C	53	3191	616
5	C	2	54	C	1
6	C	12	55	5	17
7	C	0	56	60	24
8	C	C	57	C	C
9	52	4	58	203	275
10	599	51	59	187C	781
11	C	0	60	C	C
12	3C	6	61	257	234
13	2	3	62	79	101
14	0	2	63	24	13
15	C	0	64	C	0
16	6	5	65	C	2
17	2	1	66	308	165
18	C	C	67	C	3
19	C	C	68	53	58
20	208	65	69	3	0
21	C	0	70	C	0
22	C	C	71	38	10
23	C	0	72	38	4
24	C	C	73	29	13
25	9	3	74	1	1
26	1	1	75	4	12
27	C	0	76	C	1
28	414	76	77	C	0
29	89	37	78	C	C
30	106	42	79	2	1
31	579	113	80	38	35
32	C	0	81	14	1C
33	C	0	82	C	1
34	59	17	83	7	0
35	12	12	84	C	1
36	C	0	85	C	2
37	C	0	86	C	C
38	C	0	87	C	0
39	26	12	88	C	C
40	38	15	89	C	0
41	171	27	90	C	C
42	2C	10	91	28	17
43	612	111	92	C	0
44	129	31	93	43	25
45	88	26	94	C	0
46	13	4	95	376	174
47	1641	35C	96	8	5
48	621	211	97	C	0
49	[illegible]4	3	98	C	0
			99	5	C

PEARL HARBOR TOTAL
STD ON HAND

FSG	-59	60-89	90-119	120-149	150-179	180-
1	0	0	0	0	42	0
2	0	C	C	0	4	0
3	C	0	0	0	0	1
4	C	C	0	C	0	C
5	C	C	0	0	0	0
6	C	C	0	C	C	0
7	C	0	0	0	0	0
8	C	C	0	C	0	0
9	51	1	0	C	0	0
10	154	79	283	73	4	6
11	C	C	0	0	0	0
12	10	C	7	13	0	0
13	1	0	0	1	0	0
14	C	0	0	0	0	0
15	C	C	0	C	C	0
16	4	0	0	2	0	0
17	C	0	0	2	0	0
18	C	0	0	0	0	0
19	C	C	C	C	C	0
20	43	14	7	15	16	113
21	C	C	0	C	0	0
22	C	C	0	0	0	0
23	C	C	C	C	C	0
24	C	C	0	0	0	0
25	1	1	1	2	1	3
26	1	0	0	0	0	0
27	C	C	C	0	0	0
28	90	0	103	84	27	110
29	13	C	4	51	8	13
30	16	5	17	34	7	27
31	129	30	132	143	33	112
32	C	C	0	0	0	0
33	C	C	C	0	0	0
34	29	16	9	2	3	0
35	1	C	4	7	0	0
36	C	0	0	C	0	0
37	C	C	C	C	C	0
38	C	0	0	C	0	0
39	4	1	0	6	2	13
40	7	9	3	2	2	15
41	50	0	70	1	42	8
42	10	C	1	0	0	9
43	80	4	47	135	18	328
44	22	1	4	42	12	48
45	10	2	2	12	10	52
46	2	1	8	1	C	1
47	450	172	98	121	85	715
48	146	60	49	79	70	217
49	C	C	C	C	1	3

PEARL HARBOR TOTAL
STD ON HAND

FSG	-59	60 -89	90-119	120-149	150-179	180-
50	0	0	0	0	0	0
51	3	3	1	1	0	10
52	0	1	0	0	0	0
53	599	246	583	704	293	766
54	0	0	0	0	0	0
55	2	1	0	0	1	1
56	15	1	4	2	1	37
57	0	0	0	0	0	0
58	58	7	8	94	11	25
59	516	88	86	419	229	532
60	0	0	0	0	0	0
61	70	24	16	62	27	58
62	26	3	10	9	22	9
63	4	1	2	0	4	13
64	0	0	0	0	0	0
65	0	0	0	0	0	0
66	37	5	44	92	29	101
67	0	0	0	0	0	0
68	11	2	9	16	3	12
69	0	0	0	0	2	1
70	0	0	0	0	0	0
71	8	0	1	1	1	27
72	1	1	0	2	2	32
73	2	0	4	15	2	6
74	0	0	0	0	0	1
75	1	0	1	1	1	0
76	0	0	0	0	0	0
77	0	0	0	0	0	0
78	0	0	0	0	0	0
79	0	2	0	0	0	0
80	24	2	5	2	2	3
81	3	0	0	2	1	8
82	0	0	0	0	0	0
83	2	0	0	0	3	2
84	0	0	0	0	0	0
85	0	0	0	0	0	0
86	0	0	0	0	0	0
87	0	0	0	0	0	0
88	0	0	0	0	0	0
89	0	0	0	0	0	0
90	0	0	0	0	0	0
91	8	1	2	13	0	4
92	0	0	0	0	0	0
93	6	0	11	11	3	12
94	0	0	0	0	0	0
95	124	47	24	31	18	132
96	2	1	5	0	0	0
97	0	0	0	0	0	0
98	0	0	0	0	0	0
99	1	0	2	0	0	2

PEARL HARBOR TOTAL
STD ON ORDER

FSG	-59	60-89	90-119	120-149	150-179	180-
1	1	0	0	0	3	0
2	3	1	5	27	71	1
3	0	0	0	2	2	0
4	0	0	0	0	0	0
5	0	0	0	0	2	0
6	0	0	0	0	12	0
7	0	0	0	0	0	0
8	0	0	0	0	0	0
9	3	1	0	0	0	0
10	29	3	4	6	5	4
11	0	0	0	0	0	0
12	1	1	2	0	0	2
13	0	0	0	0	0	3
14	0	0	0	0	1	1
15	0	0	0	0	0	0
16	3	2	0	0	0	0
17	0	0	0	1	0	0
18	0	0	0	0	0	0
19	0	0	0	0	0	0
20	32	5	3	6	7	12
21	0	0	0	0	0	0
22	0	0	0	0	0	0
23	0	0	0	0	0	0
24	0	0	0	0	0	0
25	1	1	0	1	0	0
26	1	0	0	0	0	0
27	0	0	0	0	0	0
28	44	9	12	7	2	2
29	23	1	4	7	0	2
30	25	6	1	4	0	6
31	63	9	10	18	9	4
32	0	0	0	0	0	0
33	0	0	0	0	0	0
34	7	4	2	2	1	1
35	8	1	2	0	0	1
36	0	0	0	0	0	0
37	0	0	0	0	0	0
38	0	0	0	0	0	0
39	4	0	1	2	0	5
40	11	1	1	1	0	1
41	17	1	5	0	1	3
42	2	2	0	1	2	3
43	66	10	8	12	3	12
44	19	2	3	3	2	2
45	14	5	3	4	0	2
46	3	0	1	0	0	0
47	222	44	16	21	15	32
48	104	35	20	15	17	20
49	1	1	0	2	0	1

FSG	-59	60-89	90-119	120-149	150-179	180-
50	0	0	0	0	0	0
51	12	0	0	2	4	4
52	0	1	0	0	0	0
53	459	44	32	38	6	37
54	0	1	0	0	0	0
55	7	9	0	1	0	0
56	12	0	5	1	0	6
57	0	0	0	0	0	0
58	220	20	11	8	6	10
59	479	48	38	34	38	144
60	0	0	0	0	0	0
61	140	25	29	13	7	20
62	54	5	11	4	11	16
63	8	0	2	0	0	3
64	0	0	0	0	0	0
65	0	0	1	1	0	0
66	102	16	17	9	9	12
67	0	1	0	1	1	0
68	23	6	8	7	3	11
69	0	0	0	0	0	0
70	0	0	0	0	0	0
71	6	1	1	1	0	1
72	2	0	0	0	1	1
73	9	1	2	0	0	1
74	1	0	0	0	0	0
75	9	0	0	1	0	2
76	1	0	0	0	0	0
77	0	0	0	0	0	0
78	0	0	0	0	0	0
79	0	0	1	0	0	0
80	15	6	10	2	0	2
81	2	0	0	3	2	3
82	0	0	0	1	0	0
83	0	0	0	0	0	0
84	1	0	0	0	0	0
85	1	1	0	0	0	0
86	0	0	0	0	0	0
87	0	0	0	0	0	0
88	0	0	0	0	0	0
89	0	0	0	0	0	0
90	0	0	0	0	0	0
91	7	1	3	2	1	3
92	0	0	0	0	0	0
93	19	0	1	2	1	2
94	0	0	0	0	0	0
95	135	11	13	1	3	11
96	2	0	0	0	1	2
97	0	0	0	0	0	0
98	0	0	0	0	0	0
99	0	0	0	0	0	0

APPENDIX E

PROGRAM AND OUTPUT FOR MARE ISLAND GENERAL MATERIAL BREAKDOWN

Data developed by this program is accumulated in four basic forms. They are as follows: for selected shops, for total DMI, by groupings of Federal Supply Groups, and selected statistics. Unit price data is to four decimal places and money value figures are to two decimal places. The definition of abbreviated terms used in the program output are as follows:

1. LI/OH - Line items on hand.
2. SUM/UP - Sum of line item unit price.
3. SUM/MVO - Sum of line item money value.
4. AVG/UP OR AV/UP - Average line item unit price.
5. AV/MVO - Average line item money value.
6. NON STANDARD - Nonstandard stock.
7. STD - Standard stock.
8. NSTD - Nonstandard stock.

The dates referred to for the oldest and most current requisition on hand are Julian dates.

```
      PROGRAM ISMARE
      DIMENSION MARE(28),SHOP(11,14), ALINE(3,5),NTEST(11),CLASS(10,2),
     1OUT(10,4)
      TYPE INTEGER CTEST
C     ESTABLISH NEEDED CONSTANTS
      DATA((SHOP(I,1),I=1,11)=11.,17.,26.,31.,36.,38.,41.,51.,56.,
     167.,71.)
      DATA((NTEST(I),I=1,11)=2H11,2H17,2H26,2H31,2H36,2H38,2H41,2H51,
     12H56,2H67,2H71)
C     THE FOLLOWING VARIABLES ARE INITIALIZED FOR PURPOSES OF
C     ACCUMULATING SUMS
      DATA(((CLASS(I,J),J=1,2),I=1,10)=20(0))
      DATA(((SHOP(I,J),J=2,14),I=1,11)=154(0))
      DATA(((ALINE(I,J),J=1,5),I=1,3)=15(0))
      DATA(((OUT(I,J),J=1,4),I=1,10)=40(0))
      REF= 5090.
      SUMJUL=0  $ OLD=6000 $ CURRENT=0  $ SUMSQR=0  $ TMNN=0
C     THE VARIABLE MNN  WILL BE USED FOR BUFFER DO LOOP PARAMETER
C     TMNN WILL MAINTAIN A COUNT OF TOTAL RECORDS READ
C     MNN WILL BE ADJUSTED FOR TAPE BEING BUFFERED IN
C     TAPE ONE,  MNN,12747 . BUFFER FOR THREE WORD HEADER
      MNN=12747   $NCOUNT=1  $  IM=2
   16 BUFFER IN(IM,0)(MARE(1),MARE(3))
   15 DO 6 I=1,MNN
      TMNN=TMNN+1
      BUFFER IN(IM,0)(MARE(1),MARE(28))
  600 IF(UNIT,IM)1,2,3,4
    1 GO TO 600
    3 PRINT 20,I,IM
   20 FORMAT(3HOI= I9,16HEOF OR EOT ERROR,3X,3HIM=I9)
      GO TO 8
    4 PRINT 21,I,IM
   21 FORMAT(3HOI=I9,12HPARITY ERROR,3X,3HIM=I9)
      GO TO 6
C     SUBROUTINES FOR CONVERTING 1604 WORDS TO USABLE FORMAT IS DONE
C     IN CONVERT. ROUTINE ANMBR CONVERTS FIELDS REQUIRING ARITHMETIC
C     MANIPULATION FROM BCD TO BINARY
    2 IF(SENSE SWITCH  5)12,32
   32 CALL CONVERT(MARE,NSHOP,NFSGRP,NUP,MVO,NDATE,NCMI,MASTR,NSYM)
      IF(MASTR .EQ. 1HA)6,31
   31 CALL ANMBR(NFSGRP,NUP,MVO,NDATE,NGRP,UP,AMVO,DATE)
C     THE FOLLOWING ROUTINES ARE TO ACCUMULATE DATA FOR TABLES AND
C     FURTHER COMPUTATION
      IF(DATE  .GT. 5090. )6,601
  601 CALL TABLE(SHOP,QTY,UP,AMVO,ALINE,NSHOP,NFSGRP,NCMI,NTEST,NSYM)
      CALL TIME (DATE,SUMJUL,OLD,CURRENT,SUMSQR,REF)
      CALL DISTR(CLASS,NCMI,NGRP,NSYM,OUT,REF,DATE)
    6 CONTINUE
    8 NCOUNT=NCOUNT+1
      REWIND IM
      PAUSE 25
      IF(NCOUNT -3)30,11,12
   30 MNN=5602  $ GO TO 15
   11 MNN=2660   $ GO TO 16
   12 REWIND IM
      CALL ACCUM(SHOP,ALINE,SUMJUL,AVCTE)
```

```
      CALL STDEV(SUMSQR,SUMJUL,ALINE,DEVJUL)
      PRINT 550
550   FORMAT( 1HO,25X,14HSTANDARD STOCK)
      PRINT 551
551   FORMAT(5HOSHOP,7X,6HLI /H,9X,6HSUM/UP,8X,7HSUM/MVO,9X,
     16HAVG/UP,9X,6HAV/MVO)
      PRINT 100,((SHOP(I,J),J=1,6),I=1,11)
100   FORMAT(F3.0,5F15.0///)
      PRINT 552
552   FORMAT(1HO,26X,12HNON STANDARD)
      PRINT 551
      DO 200 I=1,11
      PRINT 101, SHOP(I,1),(SHOP(I,J),J=7,11)
101   FORMAT(F3.0, 5F15.0///)
200   CONTINUE
      PRINT 553
553   FORMAT(1HO,14X,5HTOTAL)
      PRINT 554
554   FORMAT(1HO,11X,6HLI O/H,8X,7HSUM/MVO,9X,6HAV/MVO )
      DO 201 I=1,11
      PRINT 105, SHOP(I,1),(SHOP(I,J),J=12,14)
105   FORMAT(F3.0,3F15.0///)
201   CONTINUE
      PRINT 563
563   FORMAT(1HO,8X,6HLI O/H,9X,6HSUM/UP,8X,7HSUM/MVO,10X,5HAV/UP,
     19X,6HAV/MVO)
      PRINT 102, ((ALINE(I,J),J=1,5),I=1,3)
102   FORMAT(5F15.0///)
      PRINT 555
555   FORMAT(27X,3HSTD,11X,4HNSTD)
      PRINT 104, ((CLASS(I,J),J=1,2),I=1,10)
104   FORMAT(15X,2F15.0///)
      PRINT 560
560   FORMAT(1HO,45X,13HREQN HELD 30-///)
      PRINT 580
580   FORMAT(37X,3HSTD,27X,4HNSTD//)
      PRINT 561
561   FORMAT(1HO,25X,5H30-59,13X,3H60-,10X,5H30-59,12X,3H60-)
      PRINT  562,((CUT(I,J),J=1,4),I=1,10)
562   FORMAT(16X,4F15.0///)
      PRINT 103,OLD,CURRENT,AVDTE
103   FORMAT(28HOREFER REQN ON HAND--OLDEST= F10.0,5X,
     113HMOST CURRENT=  F10.0,5X,13HAVG DAY HELD=  F10.2)
      PRINT 108, DEVJUL
108   FORMAT(21HOSTD DEV FOR AVG DATE     F10.2///)
500   END
      SUBROUTINE CONVERT (MARE,NSHOP,NFSGRP,NUP,MVO,NDATE,NDMI,MASTR,
     1NSYM)
      DIMENSION MARE(28)
      TYPE INTEGER CTEST
      CTEST=8H
      DECODE(8,12,MARE(1))CTEST
12    FORMAT(1X,A1)
      IF(CTEST .EQ.  1HC       )14,15
14    NDATE=4H2182            $ GO TO 16
15    DECODE(8,1,MARE(1))NDATE
1     FORMAT(1X,A4)
16    DECODE(8,2,MARE(3))NSHOP
2     FORMAT(6X,A2)
      DECODE(8,3,MARE(11))NTEMP
3     FORMAT(2X,A6)
      ENCODE(10,4,MVO)NTEMP,MARE(12)
4     FORMAT( A6,A4)
      DECODE(8,5,MARE(12))NTEMP
5     FORMAT( 4X,A4)
      ENCODE(11,6,NUP)NTEMP,MARE(13)
6     FORMAT( A4,A7)
      DECODE(8,7,MARE(14))MASTR
7     FORMAT(3X,A1)
      DECODE(8,8,MARE(14))TEMP
8     FORMAT(6X,A2)
      ENCODE(3,9,NDMI)NTEMP,MARE(15)
9     FORMAT(A2,A1)
      NFSGRP=8H
      DECODE(8,10,MARE(15))NFSGRP
10    FORMAT(1X,A2)
      DECODE(8,11,MARE(15))NSYM
11    FORMAT(5X,R1)
      RETURN
      END
```

```
      SUBROUTINE ANMER(NFSGRP,NUP,MVO,NDATE,NGRP,UP,AMVO,DATE)
      DIMENSION INPUT(11),NEG(9),NPOS(9)
      DATA((NEG(I),I=1,9)=1RA,1RB,1RC,1RD,1RE,1RF,1RG,1RH,1RI)
      DATA((NPOS(I),I=1,9)=1RJ,1RK,1RL,1RM,1RN,1RO,1RP,1RQ,1RR)
      DECODE(2,1,NFSGRP)(INPUT(I),I=1,2)
    1 FORMAT(2R1)
      NGRP=0
      DO 2 I=1,2
      NGRP=NGRP*10
    2 NGRP=NGRP+INPUT(I)
      DECODE(11,3,NUP)(INPUT(I),I=1,11)
    3 FORMAT(11R1)
      UP=0
      DO 4 I=1,11
      IF(INPUT(I).EQ. 1R  .OR.  INPUT(I) .EQ. 1R0  .OR. INPUT(I) .EQ.
     11R+)5,6
    5 INPUT(I)=0    $ GO TO 91
    6 DO 7 J=1,9
      IF(NEG(J) .EQ. INPUT(I))9,10
    9 INPUT(I)=J    $ FAC=1. $GO TO 14
   10 IF(NPOS(J) .EQ. INPUT(I))11,91
   11 INPUT(I)=J  $   FAC=-1.   $ GO TO 14
    7 CONTINUE
   91 FAC =1.
   14 UP=UP*10.
      ADD=INPUT(I)
    4 UP=UP+ADD
      UP=UP*FAC
      DECODE(10,12,MVO)(INPUT(I),I=1,10)
   12 FORMAT(10R1)
      AMVO=0
      DO 34 I=1,10
      IF(INPUT(I) .EQ. 1R .OR.INPUT(I).EQ. 1R0 .OR. INPUT(I) .EQ.
     11R+)15,16
   15 INPUT(I)=0  $ GO TO 29
   16 DO 17 J=1,9
      IF(NEG(J) .EQ. INPUT(I))19,20
   19 INPUT(I)=J  $ FAC=1.$ GO TO 24
   20 IF(NPOS(J) .EQ. INPUT(I))21,29
   21 INPUT(I)=J  $FAC=-1.  $ GO TO 24
   17 CONTINUE
   29 FAC=1.
   24 AMVO=AMVO*10.
      ADD=INPUT(I)
   34 AMVO=AMVO+ADD
      AMVO=AMVO*FAC
      DECODE(4,40,NDATE)(INPUT(I),I=1,4)
   40 FORMAT(4R1)
      DO 44 I =2,4
      IF(INPUT(I)  .GT.   12  )45,44
   45 DATE =6000.   $ GO TO 46
   44 CONTINUE
      DATE=0
      DO 41 I=1,4
      DATE=DATE*10.
      ADD=INPUT(I)
   41 DATE=DATE+ADD
   46 RETURN
      END
```

```
      SUBROUTINE TIME(DATE,SUMJUL,OLD,CURRENT,SUMSQR,REF)
      IF(DATE .GT. CURRENT)1,2
    1 CURRENT=DATE $ GO TO 4
    2 IF(DATE .LT. OLD)3,4
    3 OLD=DATE
    4 IF( DATE .LT. 2000.)600,601
  600 ATEMP=1365. -DATE
      ATEMP=ATEMP+1095.+REF-5000.
      GO TO 7
  601 IF(DATE .LT. 3000.) 602,603
  602 ATEMP=2365-DATE
      ATEMP=ATEMP+730.+REF-5000.
      GO TO 7
  603 IF(DATE .LT. 4000.)604,605
  604 ATEMP=3365. -DATE
      ATEMP=ATEMP+365.+REF-5000.
      GO TO 7
  605 IF(DATE .LT. 5000.)606,607
  606 ATEMP=4365. -DATE
      ATEMP=ATEMP+ REF-5000.
      GO TO 7
  607 ATEMP=REF-DATE
    7 SUMJUL=SUMJUL+ATEMP
      SUMSQR=SUMSQR+ATEMP*ATEMP
    5 RETURN
      END
```

```
      SUBROUTINE DISTR(CLASS,NDMI,NGRP,NSYM,CUT,REF,DATE)
      DIMENSION  CLASS(10,2) ,CUT(10,4)
      N=10
      DO 20 I=1,9
      N=N+10
      IF(NGRP  .LT.  N)21,20
   21 IF(NDMI .EQ. 3HDMI)23,24
   23 CLASS(I,2)=CLASS(I,2)+1.
      IF(REF-DATE .GE. 30.)60,25
   60 IF(REF-DATE .LT. 60.)61,62
   61 CUT(I,3)=CUT(I,3) +1. $ GO TO 25
   62 CUT(I,4) = CUT(I,4) +1. $ GO TO 25
   24 IF(NSYM .GT. 12)23,26
   26 CLASS(I,1)=CLASS(I,1)+1.
      IF(REF-DATE .GE. 30.)70,25
   70 IF(REF-DATE .LT.  60.)71,72
   71 CUT(I,1)=CUT(I,1) +1. $ GO TO 25
   72 CUT(I,2) = CUT(I,2)+1. $ GO TO 25
   20 CONTINUE
      CLASS(10,2)=CLASS(10,2)+1.
      IF(REF-DATE  .GE.  30.)90,25
   90 IF(REF-DATE  .LT. 60.)91,92
   91 CUT(10,3)=CUT(10,3) +1.  $ GO TO 25
   92 CUT(10,4)= CUT(10,4) +1.
   25 RETURN
      END
```

```
      SUBROUTINE TABLE(SHOP,QTY,UP,AMVO,ALINE,NSHOP,NFSGRP,NDMI,
     1NTEST,NSYM)
      DIMENSION  SHOP(11,14),ALINE(3,5),NTEST(11)
      DO 21 I=1,11
      IF(NTEST(I) .EQ. NSHOP)20,21
   21 CONTINUE
C     CHECK IF STD. IF STD,M=1. IF NONSTD,M=2.
      IF(  NFSGRP .EQ. 1H    ) 30,60
   60 IF(NDMI .EQ. 3HDMI)30,31
   31 IF(NSYM  .GT.   12)30,41
   41 M=1   $ GO TO 32
   30 M=2
   32 ALINE(M,1)=ALINE(M,1)+1.
      ALINE(M,2)=ALINE(M,2)+UP
      ALINE(M,3)=ALINE(M,3)+AMVO
   35 RETURN
C     ACCUMULATE BY DESIGNATED SHOP
C     IF STD STK, M=1. IF NON STD,M=2.
   20 IF(NFSGRP   .EQ.  1H    )71,45
   45 IF(NDMI   .EQ. 3HDMI)55,56
   56 IF(NSYM   .GT.  12)55,71
   55 M=1   $ GO TO 57
   71 M=2
   57 SHOP(I,M)=SHOP(I,M)+1.
      SHOP(I,M+1)=SHOP(I,M+1)+UP
      SHOP(I,M+2)=SHOP(I,M+2)+AMVO
      SHOP(I,12)=SHOP(I,12)+1.
      SHOP(I,13)=SHOP(I,13)+AMVO
      GO TO 60
      END
```

965 SPEC

```
      SUBROUTINE ACCUM(SHOP,ALINE,SUMJUL,AVDTE)
      DIMENSION  SHOP(11,14),ALINE(3,5)
      DO 1 N= 1,11
      SHOP(N,5)=SHOP(N,3)/SHOP(N,2)
      SHOP(N,6)=SHOP(N,4)/SHOP(N,2)
      SHOP(N,10)=SHOP(N,8)/SHOP(N,7)
      SHOP(N,11)=SHOP(N,9)/SHOP(N,7)
    1 SHOP(N,14)=SHOP(N,13)/SHOP(N,12)
      DO 2 N=1,2
      ALINE(N,4)=ALINE(N,2)/ALINE(N,1)
    2 ALINE(N,5)=ALINE(N,3)/ALINE(N,1)
      ALINE(3,1)=ALINE(1,1)  +ALINE(2,1)
      ALINE(3,2)=ALINE  (1,2)+ALINE(2,2)
      ALINE(3,3)=ALINE(1,3)  +ALINE(2,3)
      ALINE(3,4)=ALINE(3,2)/ALINE(3,1)
      ALINE(3,5)=ALINE(3,3)/ALINE(3,1)
      AVDTE=SUMJUL/ALINE(3,1)
      RETURN
      END
```

```
      SUBROUTINE STDEV(SUMSQR,SUMJUL,ALINE,DEVJUL)
      DIMENSION ALINE(3,5)
      DEVJUL=SQRTF(SUMSQR/ALINE(3,1)-(SUMJUL*SUMJUL)/(ALINE(3,1)*
     1ALINE(3,1)))
      RETURN
      END
```

MARE ISLAND
STANDARD STOCK

SHOP	LI /OH	SUM/UP	SUM/MVO	AVG/UP	AV/MVO
11	113	6371158	6473051	56382	57284
17	45	11109925	357624	246887	7947
26	9	153006	1816626	17001	201847
31	452	88489309	9213693	195773	20384
36	23	392259	116593	17055	5069
38	238	363178099	15416205	1525958	64774
41	0	0	0	0	0
51	334	300557592	7163126	899873	21446
56	676	80599779	15804353	119230	23379
67	39	1664419	31958	42677	819
71	3	155474	303968	51825	101323

NON STANDARD

SHOP	LI /OH	SUM/UP	SUM/MVO	AVG/UP	AV/MVO
11	845	66300832	92202399	78463	109115
17	489	311993871	16629115	638024	34006
26	170	2371912	10823159	13952	63666
31	3146	1269799936	78378700	403624	24914
36	108	9415333	930896	87179	8619
38	597	1437533288	29931453	2407928	50136
41	0	0	0	0	0
51	872	1227005650	45664215	1407117	52367
56	9620	4321942720	239834087	449266	24931
67	46	82553666	1024564	1794645	22273
71	22	2022698	1214487	91941	55204

TOTAL

SHOP	LI O/H	SUM/MVO	AV/MVO
11	958	98675450	103002
17	534	16986739	31810
26	179	12639785	70613
31	3598	87592393	24345
36	131	1047489	7996
38	835	45347658	54309
41	0	0	0
51	1206	52827341	43804
56	10296	255638440	24829
67	85	1056522	12430
71	25	1518455	60738

MARE ISLAND
COLLECTIVE UMI DATA

	LI O/H	SUM/UP	SUM/MVO	AV/UP	AV/MVO
STD STK	1994	482291978	47654980	241872	23899
NSTD STK	16179	9233694388	543238576	570721	33577
TOTAL	18173	9715986266	590893556	534639	32515

FSG DISTRIBUTION

FSG	STD	NSTD
-19	0	3
20-29	2	18
30-39	39	355
40-49	672	9969
50-59	764	3054
60-69	80	774
70-79	2	42
80-89	6	32
90-99	417	1890
Unidentified	0	54

30 OR MORE FSG DISTRIBUTION
REQN HELD 30-

	STD		NSTD	
FSG	30-59	60-	30-59	60-
-19	C	0	1	2
20-29	C	2	6	12
30-39	5	30	60	28C
40-49	5C	577	426	9109
50-59	67	621	205	2664
60-69	1	57	72	677
70-79	C	2	4	38
80-89	C	5	4	28
90-99	25	355	64	1730
Unidentified	C	0	2	50

REFER REQN ON HAND--OLDEST= 2182 MOST CURRENT= 5090 AVG DAY HELD= 681.62
STD DEV FOR AVG DATE 353.94

APPENDIX F

PROGRAM AND OUTPUT FOR MARE ISLAND FINE MATERIAL BREAKDOWN

Data developed by this program is accumulated by Federal Supply Group for standard stock and nonstandard stock material on hand. A further breakdown is made showing the data in 30 day increments between 60 and 179 days. The definition of abbreviated terms used in the program output are as follows:

1. FSG - Federal Supply Group.
2. STD - Standard stock.
3. NON STD - Nonstandard stock.

```
      PROGRAM ISMARE
      DIMENSION MARE(28)   ,CLASS(100,3),OUT(100,13)
      TYPE INTEGER CTEST
C     ESTABLISH NEEDED CONSTANTS
C     THE FOLLOWING VARIABLES ARE INITIALIZED FOR PURPOSES OF
C     ACCUMULATING SUMS
      DO 900 I=1,100
      CLASS(I,1)=I    $ CLASS(I,2)=0 $ CLASS(I,3)=0
  900 OUT(I,1)=I
      DO 901 I=1,100
      DO 901 J=2,13
  901 OUT(I,J)=0
      REF=5090.   $TMNN=0
C     THE VARIABLE MNN  WILL BE USED FOR BUFFER DO LOOP PARAMETER
C     TMNN WILL MAINTAIN A COUNT OF TOTAL RECORDS READ
C     MNN WILL BE ADJUSTED FOR TAPE BEING BUFFERED IN
C     TAPE ONE,  MNN,12747 . BUFFER FOR THREE WORD HEADER
      MNN=12747    $NCOUNT=1  $   IM=2
   16 BUFFER IN(IM,0)(MARE(1),MARE(3))
  668 IF(UNIT,IM)668,15,15,15
   15 DO 6 I=1,MNN
      TMNN=TMNN+1
      BUFFER IN(IM,0)(MARE(1),MARE(28))
  600 IF(UNIT,IM)1,2,3,4
    1 GO TO 600
    3 PRINT 20,I,IM
   20 FORMAT(3HOI= I9,16HEOF OR EOT ERROR,3X,3HIM=I9)
      GO TO 8
    4 PRINT 21,I,IM
   21 FORMAT(3HOI=I9,12HPARITY ERROR,3X,3HIM=I9)
      GO TO 6
C     SUBROUTINES FOR CONVERTING 1604 WORDS TO USABLE FORMAT IS DONE
C     IN CONVERT. ROUTINE ANMBR CONVERTS FIELDS REQUIRING ARITHMETIC
C     MANIPULATION FROM BCD TO BINARY
    2 IF(SENSE SWITCH  5)12,32
   32 CALL CONVERT(MARE,NSHOP,NFSGRP,NUP,MVO,NDATE,NDMI,MASTR,NSYM)
      IF(MASTR .EQ. 1HA)6,31
   31 CALL ANMBR(NFSGRP,NUP,MVO,NDATE,NGRP,UP,AMVO,DATE)
C     THE FOLLOWING ROUTINES ARE TO ACCUMULATE DATA FOR TABLES AND
C     FURTHER COMPUTATION
      IF(DATE  .GT. 5090. )6,601
  601 CALL DISTR(CLASS,NDMI,NGRP,NSYM,OUT,REF,DATE)
    6 CONTINUE
    8 NCOUNT=NCOUNT+1
      REWIND IM
      PAUSE 25
      IF(NCOUNT -3)30,11,12
   30 MNN=5602   $ GO TO 15
   11 MNN=2660    $ GO TO 16
   12 REWIND IM
      PRINT 551
  551 FORMAT(1H0,3HFSG,12X,3HSTD,8X, 7HNON STD)
      PRINT 552, ((CLASS(I,J),J=1,3),I=1,100)
  552 FORMAT(F4.0,2F15.0/)
      PRINT 550
  550 FORMAT(1H0,40X,11HSTD ON HAND)
```

```
      PRINT 553
  553 FORMAT(1H0,3HFSG,12X,3H-59,10X ,5H60-89,  9X,6H90-119,8X,
     17H120-149,  8X,7H150-179, 11X ,4H180-)
      PRINT 554,  ((OUT(I,J),J=1,7),I=1,100)
  554 FORMAT(F4.0,6F15.0/)
      PRINT 555
  555 FORMAT(1H0,40X,  15HNON STD ON HAND)
      PRINT 553
      DO 557 I=1,100
      PRINT 556,OUT(I,1),(OUT(I,J),J=8,13)
  556 FORMAT(F4.0,6F15.0/)
  557 CONTINUE
  500 END
```

```
      SUBROUTINE CONVERT (MARE,NSHOP,NFSGRP,NUP,MVO,NDATE,NDMI,MASTR,
     1NSYM)
      DIMENSION MARE(28)
      TYPE INTEGER CTEST
      CTEST=8H
      DECODE(8,12,MARE(1))CTEST
   12 FORMAT(1X,A1)
      IF(CTEST .EQ.  1HC       )14,15
   14 NDATE=4H2182            $ GO TO 16
   15 DECODE(8,1,MARE(1))NDATE
    1 FORMAT(1X,A4)
   16 DECODE(8,2,MARE(3))NSHOP
    2 FORMAT(6X,A2)
      DECODE(8,3,MARE(11))NTEMP
    3 FORMAT(2X,A6)
      ENCODE(10,4,MVO)NTEMP,MARE(12)
    4 FORMAT( A6,A4)
      DECODE(8,5,MARE(12))NTEMP
    5 FORMAT( 4X,A4)
      ENCODE(11,6,NUP)NTEMP,MARE(13)
    6 FORMAT( A4,A7)
      DECODE(8,7,MARE(14))MASTR
    7 FORMAT(3X,A1)
      DECODE(8,8,MARE(14))TEMP
    8 FORMAT(6X,A2)
      ENCODE(3,9,NDMI)NTEMP,MARE(15)
    9 FORMAT(A2,A1)
      NFSGRP=8H
      DECODE(8,10,MARE(15))NFSGRP
   10 FORMAT(1X,A2)
      DECODE(8,11,MARE(15))NSYM
   11 FORMAT(5X,R1)
      RETURN
      END
```

```
      SUBROUTINE ANMBR(NFSGRP,NUP,MVO,NDATE,NGRP,UP,AMVO,DATE)
      DIMENSION INPUT(11),NEG(9),NPOS(9)
      DATA((NEG(I),I=1,9)=1RA,1RB,1RC,1RD,1RE,1RF,1RG,1RH,1RI)
      DATA((NPOS(I),I=1,9)=1RJ,1RK,1RL,1RM,1RN,1RO,1RP,1RQ,1RR)
      DECODE(2,1,NFSGRP)(INPUT(I),I=1,2)
    1 FORMAT(2R1)
      NGRP=0
      DO 2 I=1,2
      NGRP=NGRP*10
    2 NGRP=NGRP+INPUT(I)
      DECODE(11,3,NUP)(INPUT(I),I=1,11)
    3 FORMAT(11R1)
      UP=0
      DO 4 I=1,11
      IF(INPUT(I).EQ. 1R  .OR.  INPUT(I) .EQ. 1RO  .OR. INPUT(I) .EQ.
     11R+)5,6
    5 INPUT(I)=0    $ GO TO 91
    6 DO 7 J=1,9
      IF(NEG(J) .EQ. INPUT(I))9,10
    9 INPUT(I)=J    $ FAC=1. $GO TO 14
   10 IF(NPOS(J) .EQ. INPUT(I))11,91
   11 INPUT(I)=J  $  FAC=-1.  $ GO TO 14
    7 CONTINUE
   91 FAC =1.
   14 UP=UP*10.
      ADD=INPUT(I)
    4 UP=UP+ADD
      UP=UP*FAC
      DECODE(10,12,MVO)(INPUT(I),I=1,10)
   12 FORMAT(10R1)
      AMVO=0
      DO 34 I=1,10
      IF(INPUT(I) .EQ. 1R .OR.INPUT(I).EQ. 1RO .OR. INPUT(I) .EQ.
     11R+)15,16
   15 INPUT(I)=0  $ GO TO 29
   16 DO 17 J=1,9
      IF(NEG(J) .EQ. INPUT(I))19,20
   19 INPUT(I)=J  $ FAC=1.$ GO TO 24
   20 IF(NPOS(J) .EQ. INPUT(I))21,29
   21 INPUT(I)=J  $FAC=-1.  $ GO TO 24
   17 CONTINUE
   29 FAC=1.
   24 AMVO=AMVO*10.
      ADD=INPUT(I)
   34 AMVO=AMVO+ADD
      AMVO=AMVO*FAC
      DECODE(4,40,NDATE)(INPUT(I),I=1,4)
   40 FORMAT(4R1)
      DO 44 I =2,4
      IF(INPUT(I)  .GT.   12  )45,44
   45 DATE =6000.   $ GO TO 46
   44 CONTINUE
      DATE=0
      DO 41 I=1,4
      DATE=DATE*10.
      ADD=INPUT(I)
   41 DATE=DATE+ADD
   46 RETURN
      END
```

```
      SUBROUTINE DISTR(CLASS,NDMI,NGRP,NSYM,OUT,REF,DATE)
      DIMENSION CLASS (100,3) ,OUT(100,13)
      IF(DATE .LT. 4000.)50,51
   50 TEMP=200.   $ GO TO 54
   51 IF(DATE   .LT. 5000.)52,53
   52 TEMP=4365.-DATE
      TEMP=TEMP+REF-5000.    $ GO TO 54
   53 TEMP=REF-DATE
   54 DO 20 I=1,100
      IF(NGRP    .EQ. I)18,20
   18 IF(NDMI   .EQ. 3HDMI .OR. NSYM .GT. 12)22,23
   22 J=3    $NN=6  $  GO TO 41
   23 J=2   $  NN=0
   41 N=30
      DO 40 JA=2,6
      JJ=JA+NN
      N=N+30
      IF( TEMP     .LT. N) 30,40
   30 OUT(I,JJ)=OUT(I,JJ)+1.   $ GO TO 42
   40 CONTINUE
      OUT(I,JJ+1)=OUT(I,JJ+1)+1.
   42 CLASS(I,J)=CLASS(I,J)+1.   $ GO TO 25
   20 CONTINUE
   25 RETURN
      END
```

MARE ISLAND TOTAL

FSG	STD	NON STD	FSG	STD	NON STD
1	0	0	50	5	30
2	0	0	51	14	45
3	0	0	52	0	1
4	0	0	53	412	2232
5	0	0	54	0	6
6	0	0	55	1	2
7	0	0	56	46	292
8	0	0	57	0	0
9	0	0	58	4	15
10	0	0	59	282	431
11	0	0	60	0	0
12	0	1	61	22	210
13	0	0	62	24	18
14	0	0	63	2	13
15	0	0	64	0	0
16	0	1	65	0	0
17	0	0	66	27	522
18	0	1	67	0	0
19	0	0	68	5	11
20	0	0	69	0	0
21	0	0	70	0	0
22	0	0	71	0	9
23	0	0	72	1	22
24	0	0	73	1	8
25	2	0	74	0	0
26	0	0	75	0	1
27	0	0	76	0	2
28	0	16	77	0	0
29	0	2	78	0	0
30	8	29	79	0	0
31	21	125	80	0	0
32	0	0	81	3	28
33	0	0	82	0	0
34	6	182	83	3	4
35	1	1	84	0	0
36	0	0	85	0	0
37	0	0	86	0	0
38	0	0	87	0	0
39	3	18	88	0	0
40	16	190	89	0	0
41	5	30	90	5	38
42	1	23	91	0	9
43	5	80	92	0	0
44	1	14	93	4	200
45	10	124	94	0	0
46	0	1	95	408	1618
47	587	8249	96	0	6
48	42	1254	97	0	0
49	5	3	98	0	0
			99	0	19

MARE ISLAND TOTAL
STD ON HAND

FSG	-59	60-89	90-119	120-149	150-179	180-
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	0	0	0	0	0	0
7	0	0	0	0	0	0
8	0	0	0	0	0	0
9	0	0	0	0	0	0
10	0	0	0	0	0	0
11	0	0	0	0	0	0
12	0	0	0	0	0	0
13	0	0	0	0	0	0
14	0	0	0	0	0	0
15	0	0	0	0	0	0
16	0	0	0	0	0	0
17	0	0	0	0	0	0
18	0	0	0	0	0	0
19	0	0	0	0	0	0
20	0	0	0	0	0	0
21	0	0	0	0	0	0
22	0	0	0	0	0	0
23	0	0	0	0	0	0
24	0	0	0	0	0	0
25	0	0	0	0	0	2
26	0	0	0	0	0	0
27	0	0	0	0	0	0
28	0	0	0	0	0	0
29	0	0	0	0	0	0
30	5	0	0	0	0	3
31	1	1	0	0	0	19
32	0	0	0	0	0	0
33	0	0	0	0	0	0
34	1	2	0	0	0	3
35	0	0	0	0	0	1
36	0	0	0	0	0	0
37	0	0	0	0	0	0
38	0	0	0	0	0	0
39	2	0	0	0	0	1
40	3	0	0	0	0	13
41	3	0	0	0	0	2
42	0	0	0	0	0	1
43	4	0	0	0	0	1
44	0	0	0	0	0	1
45	4	0	0	0	0	6
46	0	0	0	0	0	0
47	62	23	0	0	0	502
48	17	2	0	0	0	23
49	2	0	0	0	0	3

MARE ISLAND TOTAL
STD ON HAND

FSG	-59	60-89	90-119	120-149	150-179	180-
50	0	0	0	0	0	5
51	4	0	0	0	0	10
52	0	0	0	0	0	0
53	53	6	0	0	0	353
54	0	0	0	0	0	0
55	1	0	0	0	0	0
56	3	1	0	0	0	42
57	0	0	0	0	0	0
58	2	0	0	0	0	2
59	80	5	0	0	0	197
60	0	0	0	0	0	0
61	7	0	0	0	0	15
62	8	0	0	0	0	16
63	0	0	0	0	0	2
64	0	0	0	0	0	0
65	0	0	0	0	0	0
66	6	0	0	0	0	21
67	0	0	0	0	0	0
68	2	0	0	0	0	3
69	0	0	0	0	0	0
70	0	0	0	0	0	0
71	0	0	0	0	0	0
72	0	0	0	0	0	1
73	0	0	0	0	0	1
74	0	0	0	0	0	0
75	0	0	0	0	0	0
76	0	0	0	0	0	0
77	0	0	0	0	0	0
78	0	0	0	0	0	0
79	0	0	0	0	0	0
80	0	0	0	0	0	0
81	0	0	0	0	0	3
82	0	0	0	0	0	0
83	1	0	0	0	0	2
84	0	0	0	0	0	0
85	0	0	0	0	0	0
86	0	0	0	0	0	0
87	0	0	0	0	0	0
88	0	0	0	0	0	0
89	0	0	0	0	0	0
90	1	0	0	0	0	4
91	0	0	0	0	0	0
92	0	0	0	0	0	0
93	2	0	0	0	0	2
94	0	0	0	0	0	0
95	59	8	0	0	0	341
96	0	0	0	0	0	0
97	0	0	0	0	0	0
98	0	0	0	0	0	0
99	0	0	0	0	0	0

MARE ISLAND TOTAL
NON STD ON HAND

FSG	-59	60-89	90-119	120-149	150-179	180-
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	0	0	0	0	0	0
7	0	0	0	0	0	0
8	0	0	0	0	0	0
9	0	0	0	0	0	0
10	0	0	0	0	0	0
11	0	0	0	0	0	0
12	0	0	0	0	0	1
13	0	0	0	0	0	0
14	0	0	0	0	0	0
15	0	0	0	0	0	0
16	1	0	0	0	0	0
17	0	0	0	0	0	0
18	0	0	0	0	0	1
19	0	0	0	0	0	0
20	0	0	0	0	0	0
21	0	0	0	0	0	0
22	0	0	0	0	0	0
23	0	0	0	0	0	0
24	0	0	0	0	0	0
25	0	0	0	0	0	0
26	0	0	0	0	0	0
27	0	0	0	0	0	0
28	6	4	0	0	0	6
29	0	0	0	0	0	2
30	14	7	0	0	0	8
31	9	6	0	0	0	110
32	0	0	0	0	0	0
33	0	0	0	0	0	0
34	52	0	0	0	0	130
35	0	0	0	0	0	1
36	0	0	0	0	0	0
37	0	0	0	0	0	0
38	0	0	0	0	0	0
39	0	0	0	0	0	18
40	22	8	0	0	0	160
41	8	1	0	0	0	21
42	9	0	0	0	0	14
43	13	1	0	0	0	66
44	0	2	0	0	0	12
45	29	0	0	0	0	95
46	0	0	0	0	0	1
47	608	192	0	0	0	7449
48	171	19	0	0	0	1064
49	0	0	0	0	0	3

MARE ISLAND TOTAL
NON STD ON HAND

FSG	-59	60-89	90-119	120-149	150-179	180-
50	3	0	0	0	C	27
51	1	0	0	0	0	44
52	0	0	0	0	0	1
53	248	43	0	0	0	1941
54	0	0	0	0	0	6
55	0	0	0	0	0	2
56	14	6	0	0	0	272
57	0	0	0	0	0	0
58	2	0	0	0	0	13
59	122	4	0	0	0	305
60	0	0	0	C	0	0
61	9	15	0	0	0	186
62	2	0	0	0	0	16
63	0	0	0	0	0	13
64	0	0	0	0	0	0
65	0	0	0	0	0	0
66	86	11	0	0	0	425
67	0	0	0	0	0	0
68	0	0	0	0	0	11
69	0	0	0	0	0	0
70	0	0	0	0	0	0
71	0	0	0	0	0	9
72	2	2	0	0	0	18
73	2	0	0	0	0	6
74	0	0	0	0	0	0
75	0	0	0	0	0	1
76	0	0	0	0	0	2
77	0	0	0	0	0	0
78	0	0	0	0	0	0
79	0	0	0	0	0	0
80	0	0	0	0	0	0
81	4	0	0	0	0	24
82	0	0	0	0	0	0
83	0	0	0	0	0	4
84	0	0	0	0	0	0
85	0	0	0	0	0	0
86	0	0	0	0	0	0
87	0	0	0	0	0	0
88	0	0	0	C	0	0
89	0	0	0	0	0	0
90	2	2	0	0	0	34
91	0	0	0	C	0	9
92	0	0	0	0	0	0
93	10	0	0	C	C	190
94	0	0	0	0	0	0
95	148	3	0	C	0	1467
96	0	1	0	0	0	5
97	0	0	0	C	0	0
98	0	0	0	0	0	0
99	0	0	0	C	0	19

APPENDIX G

PROGRAM AND OUTPUT FOR MATERIAL DISTRIBUTION CURVE

The program and output fit a curve of five and six degrees to nine data points. The curves for the six degree polynomial were used in the shipyard on hand and on order DMI projections.

```
      PROGRAM LSQFRST
C     FITTING A LEAST SQUARES POLYNOMIAL TO GIVEN DATA POINTS,
C     MATRIX X,Y
      DIMENSION XD(500),YD(500),X(9,9),Y(9),SUMX(12),TD(500),
     1XINV(9,9) ,A(9) ,R(500)
      DO 1 IIJI=1,2
      DO 1 IJI =1,4
      READ 2000,M,N,(XD(I), YD(I), I=1,M)
 2000 FORMAT (2I5/(6F10.5))
      X(1,1) = M
      NF = N + 1
      DO 10 I=1,M
   10 TD(I) = 1.
      NL = N + N
      DO 60 INP = 1,NL
      IF (INP - NF) 15, 25, 30
   15 SUMX(INP) = 0.
      Y(INP) = 0.
      DO 20 I=1,M
      Y(INP) = Y(INP) + TD(I)*YD(I)
      TD(I) = TD(I)*XD(I)
   20 SUMX(INP) = SUMX(INP) + TD(I)
      GO TO 60
   30 SUMX(INP) = 0.
      DO 35 I=1,M
      TD(I) = TD(I)*XD(I)
   35 SUMX(INP) = SUMX(INP) + TD(I)
      GO TO 60
   25 Y(INP) = 0.
      DO 27 I=1,M
   27 Y(INP) = Y(INP) + TD(I)*YD(I)
      GO TO 30
   60 CONTINUE
      DO 65 I=1,NF
      DO 65 J=1,NF
      IF (I + J - 2) 65,65,62
   62 X(I,J) = SUMX(I+J-2)
   65 CONTINUE
      CALL MATINV(X,XINV,NF,9)
      DO 70 I=1,NF
      A(I)=0.
      DO 70 J=1,NF
   70 A(I)=A(I)+XINV(I,J)*Y(J)
      CALL YBAR (A,XD,TD,N,M)
      CALL RESDUL (YD,TD,R,M)
      SIGMO = SIGMA (R,M,NF)
      PRINT 3000, N,M
 3000 FORMAT (1H1,32X,33HLEAST SQUARES CURVE FIT OF ORDER I2,4H TO I3,
     112HDATA POINTS//)
      GO TO (100,101,102,103)IJI
  100 PRINT 2
    2 FORMAT(1H0,49X,20HPEARL HARBOR STD STK     )
      GO TO 51
  101 PRINT 3
    3 FORMAT(1H0,49X,20HPEARL HARBOR ON ORDR     )
      GO TO 51
  102 PRINT 4
    4 FORMAT(1H0,50X,19HMARE ISLAND STD STK      )
      GO TO 51
  103 PRINT  5
    5 FORMAT(1H0,50X,19HMARE ISLAND NON STD       )
      PRINT 3051
 3051 FORMAT(///45X,30HCOEFFICIENTS OF THE POLYNOMIAL )
   51 DO 90 I=1,NF
      J=I-1
   90 PRINT 3030, J,A(I)
 3030 FORMAT(1H0,50X, 2HA(I1,4H)=  E12.5 )
      PRINT 3040, SIGMO
 3040 FORMAT (///41X,25HROOT MEAN SQUARE ERROR = E12.5)
      PRINT 3050, (XD(I),YD(I),TD(I),R(I),I=1,M)
 3050 FORMAT( 1H0, 34X,1HX,11X,10HY OBSERVED, 5X,12HY CALCULATED,
     16X,8HRESIDUAL//(30X,E12.5,4X,E12.5,4X,E12.5,4X,E12.5 ))
    1 CONTINUE
      END
```

```
      SUBROUTINE MATINV (A,X,N,LZ)
      DIMENSION A(LZ,LZ),X(LZ,LZ)
      EP = 1.E-8
      DO 1 I=1,N
      DO 1 J=1,N
    1 X(I,J)=0.
      DO 2 K=1,N
    2 X(K,K)=1.
   10 DO 34 L=1,N
      KP=0
      Z=0.
      DO 12 K=L,N
      IF(Z.GE.ABSF(A(K,L)))12,11
   11 Z=ABSF(A(K,L))
      KP=K
   12 CONTINUE
      IF(L.GE.KP)20,13
   13 DO 14 J=L,N
      Z=A(L,J)
      A(L,J)=A(KP,J)
   14 A(KP,J)=Z
      DO 15 J=1,N
      Z=X(L,J)
      X(L,J)=X(KP,J)
   15 X(KP,J)=Z
   20 IF(ABSF(A(L,L)).LE.EP)50,30
   30 IF(L.GE.N)34,31
   31 LP1=L+1
      DO 36 K=LP1,N
      IF(A(K,L).EQ.0)36,32
   32 RATIO=A(K,L)/A(L,L)
      DO 33 J=LP1,N
   33 A(K,J)=A(K,J)-RATIO*A(L,J)
      DO 35 J=1,N
   35 X(K,J)=X(K,J)-RATIO*X(L,J)
   36 CONTINUE
   34 CONTINUE
   40 DO 43 I=1,N
      I1=N+1-I
      DO 43 J=1,N
      S=0.
      IF(I1.GE.N)43,41
   41 I1P1=I1+1
      DO 42 K=I1P1,N
   42 S=S+A(I1,K)*X(K,J)
   43 X(I1,J)=(X(I1,J)-S)/A(I1,I1)
      KER=1
      RETURN
   50 WRITE (51,2000)
 2000 FORMAT (//// 10X, 15HSINGULAR MATRIX)
      END
```

```
      SUBROUTINE YBAR (A,XD,TD,N,M)
      DIMENSION A(9),XD(500),TD(500)
      NF=N+1
      DO 10 I=1,M
      TD(I) = A(NF)
      DO 10 J=1,N
      K=NF-J
   10 TD(I) = TD(I)*XD(I)+A(K)
      RETURN
      END
```

```
      SUBROUTINE RESDUL (YD,TD,R,M)
      DIMENSION YD(500),TD(500),R(500)
      DO 110 I=1,M
  110 R(I) = YD(I) - TD(I)
      RETURN
      END
```

```
      FUNCTION SIGMA (R,M,NF)
      DIMENSION R(500)
      SIGMA = 0.
      DO 120 I=1,M
  120 SIGMA = SIGMA + R(I)*R(I)
      SIGMA = SQRTF(SIGMA/FLOATF(M-NF))
      RETURN
      END
```

LEAST SQUARES CURVE FIT OF ORDER 5 TO 9DATA POINTS/

PEARL HARBOR STD STK

A(0)= 9.96111E-01

A(1)= -1.59510E 00

A(2)= 8.38001E-01

A(3)= -1.76501E-01

A(4)= 1.60242E-02

A(5)= -5.23895E-04

ROOT MEAN SQUARE ERROR = 1.28966E-01

X	Y OBSERVED	Y CALCULATED	RESIDUAL
1.00000E 00	6.10000E-02	7.80100E-02	-1.70100E-02
2.00000E 00	5.90000E-02	-1.44749E-02	7.34749E-02
3.00000E 00	6.30000E-02	1.57936E-01	-9.49358E-02
4.00000E 00	2.72000E-01	2.93367E-01	-2.13672E-02
5.00000E 00	4.35000E-01	2.85923E-01	1.49077E-01
6.00000E 00	5.90000E-02	1.62817E-01	-1.03817E-01
7.00000E 00	9.00000E-03	2.15079E-02	-1.25079E-02
8.00000E 00	5.00000E-03	-3.31696E-02	3.81696E-02
9.00000E 00	3.70000E-02	4.81274E-02	-1.11274E-02

LEAST SQUARES CURVE FIT OF ORDER 5 TO 9DATA POINTS/

PEARL HARBOR ON CRCR

A(0)= 6.53621E-01

A(1)= -9.69072E-01

A(2)= 4.54654E-01

A(3)= -7.83178E-02

A(4)= 5.04404E-03

A(5)= -7.94313E-05

ROOT MEAN SQUARE ERROR = 1.17578E-01

X	Y OBSERVED	Y CALCULATED	RESIDUAL
1.00000E 00	5.10000E-02	6.58494E-02	-1.48494E-02
2.00000E 00	4.60000E-02	-1.42880E-02	6.02880E-02
3.00000E 00	4.90000E-02	1.12973E-01	-6.39728E-02
4.00000E 00	1.98000E-01	2.49389E-01	-5.13890E-02
5.00000E 00	4.34000E-01	2.89180E-01	1.44820E-01
6.00000E 00	1.44000E-01	2.09494E-01	-6.54941E-02
7.00000E 00	1.10000E-02	6.08791E-02	-4.98791E-02
8.00000E 00	1.20000E-02	-4.22518E-02	5.42518E-02
9.00000E 00	5.50000E-02	6.88497E-02	-1.38497E-02

LEAST SQUARES CURVE FIT OF ORDER 5 TO 9 DATA POINTS/

MARE ISLAND STD STK

A(0)= 1.09642E 00

A(1)= -1.89255E 00

A(2)= 1.00734E 00

A(3)= -2.13244E-01

A(4)= 1.93058E-02

A(5)= -6.20660E-04

ROOT MEAN SQUARE ERROR = 1.18274E-01

X	Y OBSERVED	Y CALCULATED	RESIDUAL
1.00000E 00	0	1.66493E-02	-1.66493E-02
2.00000E 00	1.00000E-03	-7.62452E-02	7.72452E-02
3.00000E 00	1.90000E-02	1.40183E-01	-1.21183E-01
4.00000E 00	3.39000E-01	3.02760E-01	3.62401E-02
5.00000E 00	3.85000E-01	2.88212E-01	9.67878E-02
6.00000E 00	4.00000E-02	1.38689E-01	-9.86887E-02
7.00000E 00	1.00000E-03	-1.27192E-02	1.37192E-02
8.00000E 00	3.00000E-03	-1.64569E-02	1.94569E-02
9.00000E 00	2.12000E-01	2.19015E-01	-7.01486E-03

LEAST SQUARES CURVE FIT OF ORDER 5 TO 9 DATA POINTS/

MARE ISLAND NON STD

COEFFICIENTS OF THE POLYNOMIAL

A(0)= 1.70399E 00

A(1)= -3.06660E 00

A(2)= 1.74289E 00

A(3)= -4.04549E-01

A(4)= 4.10612E-02

A(5)= -1.51824E-03

ROOT MEAN SQUARE ERROR = 1.96776E-01

X	Y OBSERVED	Y CALCULATED	RESIDUAL
1.00000E 00	0	1.52704E-02	-1.52704E-02
2.00000E 00	2.00000E-03	-8.56475E-02	8.76475E-02
3.00000E 00	2.20000E-02	2.24403E-01	-2.02403E-01
4.00000E 00	6.18000E-01	3.89682E-01	2.28318E-01
5.00000E 00	1.88000E-01	2.93350E-01	-1.05350E-01
6.00000E 00	4.80000E-02	7.52783E-02	-2.72783E-02
7.00000E 00	3.00000E-03	-5.01399E-02	5.31399E-02
8.00000E 00	2.00000E-03	2.38210E-02	-2.18210E-02
9.00000E 00	1.17000E-01	1.14030E-01	2.97010E-03

LEAST SQUARES CURVE FIT OF ORDER 6 TO 9DATA POINTS/

PEARL HARBOR STD STK

A(0)= -1.70653E 00

A(1)= 4.00544E 00

A(2)= -3.25048E 00

A(3)= 1.22228E 00

A(4)= -2.27190E-01

A(5)= 2.02692E-02

A(6)= -6.93106E-04

ROOT MEAN SQUARE ERROR = 1.03999E-01

X	Y OBSERVED	Y CALCULATED	RESIDUAL
1.00000E 00	6.10000E-02	6.30959E-02	-2.09588E-03
2.00000E 00	5.90000E-02	4.99027E-02	9.09734E-03
3.00000E 00	6.30000E-02	7.48366E-02	-1.18366E-02
4.00000E 00	2.72000E-01	2.89650E-01	-1.76499E-02
5.00000E 00	4.35000E-01	3.61604E-01	7.33957E-02
6.00000E 00	5.90000E-02	1.59144E-01	-1.00144E-01
7.00000E 00	9.00000E-03	-6.14703E-02	7.04703E-02
8.00000E 00	5.00000E-03	3.14403E-02	-2.64403E-02
9.00000E 00	3.70000E-02	3.35330E-02	3.46698E-03

LEAST SQUARES CURVE FIT OF ORDER 6 TO 9DATA POINTS/

PEARL HARBOR ON ORDR

A(0)= -2.08437E 00

A(1)= 4.70493E 00

A(2)= -3.68746E 00

A(3)= 1.33881E 00

A(4)= -2.41359E-01

A(5)= 2.09862E-02

A(6)= -7.02191E-04

ROOT MEAN SQUARE ERROR = 7.89167E-02

X	Y OBSERVED	Y CALCULATED	RESIDUAL
1.00000E 00	5.10000E-02	5.08333E-02	1.66651E-04
2.00000E 00	4.60000E-02	5.09959E-02	-4.99588E-03
3.00000E 00	4.90000E-02	2.88045E-02	2.01955E-02
4.00000E 00	1.98000E-01	2.45599E-01	-4.75993E-02
5.00000E 00	4.34000E-01	3.65778E-01	6.82222E-02
6.00000E 00	1.44000E-01	2.05620E-01	-6.16198E-02
7.00000E 00	1.10000E-02	-2.34662E-02	3.44662E-02
8.00000E 00	1.20000E-02	2.27268E-02	-1.07268E-02
9.00000E 00	5.50000E-02	5.32965E-02	1.70345E-03

LEAST SQUARES CURVE FIT OF ORDER 6 TO 9DATA POINTS/

MARE ISLAND STD STK

A(0)= -1.10723E 00

A(1)= 2.67529E 00

A(2)= -2.32742E 00

A(3)= 9.27683E-01

A(4)= -1.79074E-01

A(5)= 1.63395E-02

A(6)= -5.65342E-04

ROOT MEAN SQUARE ERROR = 1.07632E-01

X	Y OBSERVED	Y CALCULATED	RESIDUAL
1.00000E 00	0	5.02703E-03	-5.02703E-03
2.00000E 00	1.00000E-03	-2.33731E-02	2.43731E-02
3.00000E 00	1.90000E-02	7.26371E-02	-5.36371E-02
4.00000E 00	3.39000E-01	2.99879E-01	3.91212E-02
5.00000E 00	3.85000E-01	3.50052E-01	3.49480E-02
6.00000E 00	4.00000E-02	1.35810E-01	-9.58098E-02
7.00000E 00	1.00000E-03	-8.02126E-02	8.12126E-02
8.00000E 00	3.00000E-03	3.65846E-02	-3.35846E-02
9.00000E 00	2.12000E-01	2.07703E-01	4.29724E-03

LEAST SQUARES CURVE FIT OF ORDER 6 TO 9DATA POINTS/

MARE ISLAND NON STD

COEFFICIENTS OF THE POLYNOMIAL

A(0)= 9.28683E-01

A(1)= -1.45905E 00

A(2)= 5.69187E-01

A(3)= -2.96640E-03

A(4)= -2.87674E-02

A(5)= 4.45182E-03

A(6)= -1.99009E-04

ROOT MEAN SQUARE ERROR = 2.38581E-01

X	Y OBSERVED	Y CALCULATED	RESIDUAL
1.00000E 00	0	1.13374E-02	-1.13374E-02
2.00000E 00	2.00000E-03	-6.69602E-02	6.89602E-02
3.00000E 00	2.20000E-02	2.00672E-01	-1.78672E-01
4.00000E 00	6.18000E-01	3.88682E-01	2.29318E-01
5.00000E 00	1.88000E-01	3.15080E-01	-1.27080E-01
6.00000E 00	4.80000E-02	7.41602E-02	-2.61602E-02
7.00000E 00	3.00000E-03	-7.40763E-02	7.70763E-02
8.00000E 00	2.00000E-03	4.22232E-02	-4.02232E-02
9.00000E 00	1.17000E-01	1.09618E-01	7.38246E-03

APPENDIX H

PROGRAM FOR
SHIPYARD ON HAND/ON ORDER PROJECTION
USING CURVES

Projections are developed using a six degree polynomial fitted to relative frequencies shown in Table VII. The program output is shown in Table XII.

Abbreviations used in the program output are as follows:

1. PTSMH - NSY Portsmouth
2. BSN - NSY Boston
3. PHILA - NSY Philadelphia
4. BREM - NSY Bremerton
5. MARE - NSY Mare Island
6. LBEACH - NSY Long Beach
7. SFRAN - NSY San Francisco
8. NORVA - NSY Norfolk
9. CHASN - NSY Charleston
10. PEARL - NSY Pearl Harbor
11. O/H STD - On hand standard stock.
12. O/H NSTD - On hand nonstandard stock.
13. ORDR STD - On order standard stock.
14. ORDR NSTD - On order nonstandard stock.
15. TOTL O/H - Total on hand.
16. TOTL ORD - Total on order.

```
      PRCGRAM PROJECT
      DIMENSICN NACT(12),CAT(5),DSFA(11),ANSTD(11),ANNST(11),DM1(11),
     1STEMP(11,3),TEM(11,3),CSTD(11),CNST(11),DNFA(11),ACT(12,6)
      DATA((NACT(I),I=1,12)=5HPTSMH,3HBSN,3HNYK,5HPHILA,4HBREM,
     14HMARE , 6HLBEACH , 5HSFRAN, 5HNORVA ,5HCHASN, 5HPEARL, 5HTCTAL)
      DATA((CAT(I),I=1,5)=3.,4.,5.,6.,9.)
C     DMI INVESTMENTS  CCNST  YCS
      DATA((DM1(I),I=1,11)=9115C00., 2760000., 4795000.,  2984CCC.,
     14877000.,8224000.,61CC0.,36470CC.,941000.,1015000.,1086CCC.)
C     OBTAIN RATIO OF STD TO NCN STD USING MADE AND PEARL RATICS
C     AS PROPORTICNALITY CONSTANT.
      DC 1 I=1,6
      DSFA(I)=DM1(I) *47655C./5908936.
    1 DNFA(I)=DM1(I) *5432386./5908936.
      DC 2 I=7,11
      DSFA(I)=DM1(I)*923069.47/2130980.65
    2 DNFA(I)=DM1(I)* 1207911.18/213C98C.65
      DC 30 II=1,12
      DC 30 I=1,6
   30 ACT(II,I)=0
C     PROJECT DOLLAR RATIC FCR CN HAND MATL FOR CHOSEN CATEGORIES
C     TO L/I FOR STD AND NCNSTD USING AVG LI MVC      . MARE NSTD PDF
C     WILL BE USED FCR ALL SY NCN STD.
      DO 3 I=1,6
      ANSTD(I)=DSFA(I)/238.99
    3 ANNST(I)=DNFA(I)/335.77
      DO 4 I=7,11
      ANSTD(I)=DSFA(I)/75.16
    4 ANNST(I)=DNFA(I)/550.05
C     USE MARE ISLAND PDF TO GENERATE FREQ AT CTHER CCNST YDS.
      DO 5 II=1,6
      DO 5 I = 1,5
      A=CAT(I)
      STEMP(II,I)=(-1.10723+2.67529*A-2.32742*A**2+.927683*A**3
     1-.179074*A**4 +.C163395*A**5 -.C00565342*A**6       )* ANSTD(II)
      TEM(II,I)=(.928683 -1.45905*A +.569187*A**2 -.CC29664*A**3
     1-.0287674*A**4 + .CC445182*A**5 - .000199C09*A**6)*ANNST(II)
      ACT(II,1)=ACT(II,1) +STEMP(II,I)
    5 ACT(II,2)=ACT(II,2) +TEM(II,I)
C     USE PEARL HARBCR FCR STD ON HAND TO GENERATE FREQ AT CTHER RO YDS
      DC 6 II=7,11
      DC 6 I =1,5
      A=CAT(I)
      STEMP(II,I)=(-1.70653+ 4.00544*A     -3.25C48*A**2 +1.22228*A**3
     1-.227190*A**4 +.C202692*A**5 - .000693106*A**6)*ANSTD(II)
      TEM(II,I)=(.928683 - 1.45905*A + .569187*A**2 -.0029664*A**3
     1-.0287674*A**4 +.00445182*A**5 -.00C199C09*A**6)*ANNST(II)
      ACT(II,1)=ACT(II,1) +STEMP(II,I)
    6 ACT(II,2)= ACT(II,2) +TEM(II,I)
C     USING PEARL ORDR STD/NSTD QTYS AS PROP CCNSTANTS ,GEN LI CN ORDER
C     FOR SUBJ CATEGORIES.
      DC 8 I=1,11
      CSTD(I)= ((ANSTD(I) +ANNST(I))/1.81)*3995./7999.
    8 CNST(I)= ((ANSTD(I) +ANNST(I))/1.81) *4CC4./7999.
C     USE PDF FOR PEARL CN STD ON ORDR AND  MARE NON STD PDF
      DC 9 II=1,11
```

```
      DO 9 I =1,5
      A=CAT(I)
      STEMP(II,I)=(-2.C8437+ 4.70493*A -3.68746*A**2 +1.33881*A**3
     1-.241359*A**4 +.C209862*A**5 -.CCC702191*A**6)*OSTD(II)
      TEM(II,I)=(.928683 -1.459C5*A +.569187*A**2 -.0029664*A**3
     1-.0287674*A**4 + .00445182*A**5 - .000199C09*A**6)*ONST(II)
      ACT(II,3)= ACT(II,3) +STEMP(II,I)
    9 ACT(II,4)=ACT(II,4) +TEM(II,I)
C     ACCUMULATE TOTALS
      DO 10 II=1,11
      ACT(II,5) = ACT(II,1) +ACT(II,2)
   10 ACT(II,6)=ACT(II,3) +ACT(II,4)
      DO 11 I=1,6
      DO  11 II=1,11
   11 ACT(12,I)= ACT(12,I) +ACT(II,I)
      PRINT 5003
 5003 FORMAT( 1H1)
      PRINT 20
   20 FORMAT(1HO,3HSYD   11X,7HO/H STD ,7X,8HO/H NSTD  ,7X,8HORDR STD ,
     17X,8HORD NSTD  ,7X,8HTOTL O/H ,6X,9HTOTAL ORD    )
      DO 50 II=1,12
      PRINT 21,NACT(II),(ACT(II,I),I=1,6)
   21 FORMAT( A7,6F15.0//)
   50 CONTINUE
      END
```

APPENDIX I

PROGRAM FOR SHIPYARD ON HAND/ON ORDER PROJECTION USING RELATIVE FREQUENCIES

Projections are developed using relative frequencies shown in Table VII. See Table XIII for output.

Abbreviations used in the program output are the same as indicated in Appendix H.

```
      PROGRAM PROJECT
      DIMENSION NACT(12),CAT(5),DSFA(11),ANSTD(11),ANNST(11),DM1(11),
     1STEMP(11,3),TEM(11,3),OSTD(11),ONST(11),DNFA(11),ACT(12,6)
      DIMENSION  CATMS(10),CATMN(10),CATPS(10),CATP(10)
      DATA((CATMS(I),I=1,5)=.019,.339,.385, .C4, .212)
      DATA((CATMN(I),I= 1,5)=.C22,  .618,  .188,  .048,  .117)
      DATA((CATPS(I),I=1,5)=  .C63,  .272,  .435,  .059  ,.037 )
      DATA((CATP(I),I=1,5)=  .049,  .198,.434  ,.144  ,.055)
      DATA((NACT(I),I=1,12)=5HPTSMH,3HBSN,3HNYK,5HPHILA,4HBREM,
     14HMARE ,  6HLBEACH  ,  5HSFRAN,  5HNCRVA  ,5HCHASN,  5HPEARL,  5HTCTAL)
      DATA((CAT(I),I=1,5)=3.,4.,5.,6.,9.)
C     DMI INVESTMENTS  CONST  YDS
      DATA((DM1(I),I=1,11)=9115CCO.,  276CCCO.,  4795000.,   2984C00.,
     14877CCO.,8224000.,61000.,3647CCC.,941000.,1015000.,1086CCC.)
C     OBTAIN RATIO OF STD TO NON STD USING MADE AND PEARL RATIOS
C     AS PROPORTIONALITY CONSTANT.
      DO 1 I=1,6
      DSFA(I)=DM1(I) *476550./5908936.
    1 DNFA(I)=DM1(I) *5432386./5908936.
      DO 2 I=7,11
      DSFA(I)=DM1(I)*923069.47/2130980.65
    2 DNFA(I)=DM1(I)* 1207911.18/2130980.65
      DO 30 II=1,12
      DO 30 I=1,6
   30 ACT(II,I)=0
C     PROJECT DOLLAR RATIO FOR ON HAND MATL FOR CHOSEN CATEGORIES
C     TO L/I FOR STD AND NONSTD USING AVG LI MVO      . MARE NSTD PDF
C     WILL BE USED FOR ALL SY NON STD.
      DO 3 I=1,6
      ANSTD(I)=DSFA(I)/238.99
    3 ANNST(I)=DNFA(I)/335.77
      DO 4 I=7,11
      ANSTD(I)=DSFA(I)/75.16
    4 ANNST(I)=DNFA(I)/550.05
C     USE MARE ISLAND PDF TO GENERATE FREQ AT OTHER CONST YDS.
      DO 5 II=1,6
      DO 5 I = 1,5
      STEMP(II,I) =CATMS(I) *ANSTD(II)
      TEM(II,I) = CATMN(I) *ANNST(II)
      ACT(II,1)=ACT(II,1) +STEMP(II,I)
    5 ACT(II,2)=ACT(II,2) +TEM(II,I)
C     USE PEARL HARBOR FOR STD ON HAND TO GENERATE FREQ AT OTHER RO YDS
      DO 6 II=7,11
      DO 6 I =1,5
      STEMP(II,I) = CATPS(I) * ANSTD(II)
      TEM(II,I) = CATMN(I) * ANNST(II)
      ACT(II,1)=ACT(II,1) +STEMP(II,I)
    6 ACT(II,2)= ACT(II,2) +TEM(II,I)
C     USING PEARL ORDR STD/NSTD QTYS AS PROP CONSTANTS ,GEN LI ON ORDER
C     FOR SUBJ CATEGORIES.
      DO 8 I=1,11
      OSTD(I)= ((ANSTD(I) +ANNST(I))/1.81)*3995./7999.
    8 ONST(I)= ((ANSTD(I) +ANNST(I))/1.81) *4004./7999.
C     USE PDF FOR PEARL ON STD ON ORDR AND  MARE NON STD PDF -
      DO 9 II=1,11
      DO 9 I =1,5

      STEMP(II,I) = CATP(I) *OSTD(II)
      TEM(II,I) = CATMN(I) *ONST(II)
      ACT(II,3)= ACT(II,3) +STEMP(II,I)
    9 ACT(II,4)=ACT(II,4) +TEM(II,I)
C     ACCUMULATE TOTALS
      DO 10 II=1,11
      ACT(II,5) = ACT(II,1) +ACT(II,2)
   10 ACT(II,6)=ACT(II,3) +ACT(II,4)
      DO 11 I=1,6
      DO   11 II=1,11
   11 ACT(12,I)= ACT(12,I) +ACT(II,I)
      PRINT 5003
 5003 FORMAT( 1H1)
      PRINT 20
   20 FORMAT(1H0,3HSYD    11X,7HO/H STD ,7X,8HO/H NSTD  ,7X,8HORDR STD ,
     17X,8HORD NSTD  ,7X,8HTOTL O/H ,6X,9HTOTAL ORD     )
      DO 50 II=1,12
      PRINT 21,NACT(II),(ACT(II,I),I=1,6)
   21 FORMAT( A7,6F15.0//)
   50 CONTINUE
      END
```

APPENDIX J

MARE ISLAND/PEARL HARBOR

TAPE FORMATS

Provided in this appendix are the tape formats for the DMI runs analyzed in this paper. Mare Island's DMI run was contained on two reels of magnetic tape while Pearl Harbor's DMI run was contained on three reels of magnetic tape. The computers used at Mare Island and Pearl Harbor to process these DMI files were an IBM 705 and IBM 1401 respectively.

MARE ISLAND TAPE FORMAT

INPUT/OUTPUT MASTER
TAPE FILE DM1011
DIRECT MATERIAL INVENTORY (FINANCIAL) RECORDS
VARIABLE LENGTH REC, MAXIMUM 540, UNBLOCKED
SEQUENCE DOC NR COL 2-9

LABEL

1 — 18	
DMICIIMASTR.YMODAREL	‡

1	2–9	10	11–19	20	21–22	23–24	25–32	33	34–35	36–42	43–51	52	53–62	63–72	73–81	82	83–92	93–103	104–105	106
	DOCUM NUM	SUFFIX	JOB ORDER		FUND ADM	SHOP	REFER DOC NR	SUFFIX	UNIT OF ISSUE	QUANTITY ±	MEP NUM OLD ... NEW ...	"C" IF CONVERSION	RECEIPT (2 DEC) ±	ISSUE (2 DEC) ±	ADJUST (2 DEC) ±		CHAR VALUE ±	UNIT PRICE (4 DEC) ±	FUND CODE	‡
1b	8AN	1ANb	9AN	1b	2Nb	2Nb	8ANb	1ANb	2Ab	7N	9ANb	1Ab	10N	10N	9N	1b	10N	11N		1b

CONTINUED

DETAIL 1 HISTORY*

107	108	109	110	111–125	126	127–136	137–139	140	141–143	144–148	149–157	155–162	163–172	173–174	175–181	182–183	184–189	190–191	192–199	200	201–211	212	213	214–219	220
FEATURE CONTROL C S ±	OVER FLOW MAST IND ±	STATUS CODE	PROD DEC IND	NOMENCLATURE (STOCK NUM)	1	NEW MONTH (2 DEC) OR BLANK ±	NUM OF MASTS ±		DETAIL PROC TRAN CODE	DETAIL PROC DATE YRDA	DETAIL JOB ORDER	*	DETAIL INSP RCPT NUM	DETAIL SHOP	CONTRACT NUM		QUANTITY ±		DETAIL EXTS 2 DEC ±		DETAIL UNIT PRICE 4 DEC ±	STD	STATUS OF MAT		‡
1N	1A	1ANb	1Nb	13ANb	1b	10Nb	3N	1b	3ANb	5N	9AN	2b	10ANb	2Nb	8ANb	2b	5N	2b	8N	1b	11N		1Nb	6b	

159–162 KO,WE

*DETAIL 2, 3, 4, 5 - SAME FORMAT AS DETAIL 1

FEATURE CONTROL (COL 107) "A" THRU "E" INDICATES NUM. MULTIPLE DETAILS, TO A MAXIMUM OF 5 PER MASTER. IF MORE THAN 5 DETAILS, A NEW MASTER IS CREATED AND OVERFLOW INDICATOR (COL 108) IS MADE A. MASTERS ARE NUMBERED IN ASCENDING SEQUENCE (COLS 137-139).

(1) VARIABLE LENGTH MASTER MAY CONTAIN FROM 1 TO 5 DETAILS OF HISTORY. I.E. IF ONE DETAIL, MASTER RECORD IS 220 LENGTH; TWO DETAILS, 300 LENGTH, THREE DETAILS, 380 LENGTH, FOUR DETAILS, 460 LENGTH, FIVE DETAILS 540 MAXIMUM LENGTH. REC MK IS ALWAYS LAST DIGIT OF RECORD.

NOTE. ALL ± FIELDS ARE CARRIED IN 705 COMPUTER LANGUAGE AS SIGNED NUMERICS. (SAME AS ALPHAS)

1	2	3	4	5	6	7	8	9	
A	B	C	D	E	F	G	H	I	= PLUS SIGN
J	K	L	M	N	O	P	Q	R	= MINUS SIGN

Pearl Harbor Basic Tape Format

1HDR — 001MATL M-1 XXXXX (Julian Date)

Primary Job Order #	Shop	Stock # Date	Serial	JO Stat	JO Cross Ref. / PWC Job Order #	Shop	FSC	FIIN	Addt'l	U/I	Qty	U/P	MVO	CSC	CSC dte	blank → 99

Line #2 ← 100

				PR/Contract #	CIL/APL#	PRI	ROD	Nomenclature				Supp'l Act dte	SAC dte	Date supp'd	Shop	BA or AB#	Last Proof List date	Spare